Agnel Charities

Fr. C. Rodrigues Institute of Technology

Sector 9A, Vashi, Navi Mumbai, 400703, Maharashtra, India

www.fcrit.ac.in

An Autonomous Institute Affiliated to the University of Mumbai

Department of Computer Engineering

Curriculum Structure FY to B. Tech.

&

Third Year Syllabus

Prepared by: Board of Studies for Computer Engineering

Approved By: Academic Council of Fr. C. Rodrigues Institute of Technology

Effective from :2025-26

Revision: 2024.1

PREAMBLE

Accelerating Towards Excellence: Unveiling a New Era in Education

Dear Students, Faculty, and Stakeholders,

It is with great pleasure and anticipation that we introduce the newly designed curriculum for autonomy at Agnel Charities' Fr. C. Rodrigues Institute of Technology. This pioneering initiative aims to revolutionize engineering education, ensuring our graduates are equipped with not only technical prowess but also the holistic skills necessary for thriving in today's dynamic professional landscape.

1. **Purpose of Autonomy:** Our commitment to autonomy is rooted in the imperative to bridge the gap between academia and industry. We envision education as a catalyst for individual growth, fostering self-sustainability and enhancing employability. Through our curriculum, we strive to nurture engineers who not only excel in their fields but also contribute meaningfully to society.

2. **Curriculum Design: A Top-to-Down Approach:** Our curriculum is meticulously crafted with a top-to-down approach, encompassing all 12 attributes of Program Outcomes mandated by regulatory bodies. Emphasizing a blend of theoretical knowledge and practical application, it is designed to cultivate well-rounded professionals capable of tackling real-world challenges with confidence and competence.

3. **Alignment with National Education Policy-2020:** In adherence to the guidelines laid out in the National Education Policy-2020, our curriculum embodies a multidisciplinary approach, offering a diverse array of core and elective courses. It integrates hands-on learning experiences such as mini and major projects, skill-based labs, and one-semester internships to nurture innovation and problem-solving skills. Additionally, the inclusion of value-added courses, honours, and minors ensures a comprehensive educational journey tailored to individual interests and aspirations.

4. **Opportunities for Teachers in Innovation:** We recognize the pivotal role of our faculty in shaping the educational experience. Our curriculum provides ample opportunities for teachers to innovate in teaching-learning methodologies and evaluation techniques. Through continuous professional development programs and collaborative platforms, we empower our educators to experiment with innovative pedagogies, leverage technology for enhanced learning outcomes, and implement novel assessment strategies. By fostering a culture of innovation among our faculty, we aim to enrich the learning experience and inspire a passion for lifelong learning among our students.

As we embark on this transformative journey, we invite all stakeholders to join us in shaping the future of engineering education. Together, let us strive towards excellence, innovation, and societal impact.

Sincerely,

Dean of Academics Agnel Charities' Fr. C. Rodrigues Institute of Technology

Preamble from Board of Studies

Dear Students and Stakeholders,

The Department of Computer Engineering at Fr. C. Rodrigues Institute of Technology, Vashi, was established in 1994 and the current intake capacity is 120.One of the notable achievements is accreditation by the National Board of Accreditation (NBA) in 2006, 2012, 2019 and 2021, which reflects our commitment in maintaining high standards of education and infrastructure. Our mission is to provide a dynamic learning environment where students not only acquire technical expertise but also develop critical thinking, problem-solving skills, and leadership qualities. Through rigorous academic activities, hands-on learning opportunities, and industry collaborations, we aim to prepare our graduates to thrive in today's rapidly evolving technological landscape.

It is with great pleasure and anticipation that the members of Board of Studies, Computer Engineering, at Agnel Charities' Fr. C. Rodrigues Institute of Technology are very happy to introduce the newly designed curriculum for autonomy with effect from AY 24-25.

This curriculum is tailored to shape well-rounded individuals by adopting a comprehensive educational approach. It prioritizes building a solid foundation in science, mathematics, and computer engineering, complemented by a diverse selection of elective courses aimed at honing expertise in specialized areas to gain practical experience through extensive industry or research internships. Collaboration with external entities ensures the integration of pertinent skill-building courses, while honors evaluations offer opportunities for advanced learners. Moreover, in alignment with the principles outlined in the National Education Policy-2020, mission and vision of Institute and Department, our curriculum embraces a multidisciplinary approach, integrating subjects of various disciplines to provide a distinct learning experience to students. Furthermore, the curriculum systematically fosters the development of soft skills and enriches social, physical, mental, and spiritual dimensions of personality through thoughtfully curated liberal and experiential learning. Our curriculum adopts a top-to-down approach, meticulously incorporating all 12 attributes of Program Outcomes mandated by regulatory bodies, with reference to NBA SAR-January 2016.

The salient features of the autonomy curriculum are:

1. Implementation of a credit structure that aims to afford students' more time for extracurricular activities, co-curricularactivities, innovation, internships, and research.

2. Program elective courses within the department, open elective courses and honours/minor courses will offer specialized knowledge in the respective domain to students motivating them to remain updated on emerging trends, actively participate in continuousprofessional development.

3.The inclusion of Skill-Based Labs, Mini Projects, Major projects and Internships as a part of the curriculum provides students with a platform to demonstrate their talents through innovative projects, thereby strengthening their profiles and significantly improving their employability prospects in the product, service and consultancy organizations.

We are sure you will find this curriculum interesting, challenging, fulfilling the needs and expectations of Industry, Research and Academics. We are committed to fostering holistic development and ensuring that our students are well-equipped to succeed in their chosen careers. We take immense pride in serving as a beacon of academic excellence and innovation, fueled by our unwavering commitment.

Join us as we embark on this journey of autonomy, academic excellence and innovation in the field of Computer Engineering.

Sincerely,

Chairman, Board of Studies- Computer Engineering, Fr. C. Rodrigues Institute of Technology

Contents

A. Abbreviations

AEC	Ability Enhancement Course
AU	Audit Course
BSC	Basic Science Course including Mathematics
BSL	Basic Science Laboratory Course
ELC	Experiential Learning Course
ESC	Engineering Sciences Course
ESL	Engineering Sciences Laboratory Course
HMC	Honours or Minor Core Course
HML	Honours or Minor Laboratory
HMP	Honours or Minor Mini Project
HSS	Humanities Social Sciences and Management Course
IKS	Indian Knowledge System Course
INT	Internship
L	Lecture
LBC	Laboratory Course
LLC	Liberal Learning Course
MDM	Multidisciplinary Minor Course
MDL	Multidisciplinary Laboratory Course
MJP	Major Project
MNP	Mini Project
OEC	Open Elective Course
P	Practical
PCC	Program Core Course
PEC	Program Elective Course
RPC	Research Project Coursework
RPR	Research Project
SBL	Skill Based Laboratory
SEC	Skill Enhancement Course
T	Tutorial
VEC	Value Education Course

B. Credit Structure

1. B. Tech in Computer Engineering											
Type of Course	**Semester-wise Credit Distribution**									**FCRIT Credit Distribution**	**DTE Credit Distribution**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**		
Basic Science Course (BSC)	08	08	--	--	--	--	--	--	**16**	**18**	**14-18**
Basic Science Laboratory Course (BSL)	01	01	--	--	--	--	--	--	**02**		
Engineering Science Course (ESC)	05	02	--	--	--	--	--	--	**07**	**16**	**12-16**
Engineering Science Laboratory Course (ESL)	04	05	--	--	--	--	--	--	**09**		
Program Core Course (PCC)	--	--	14	13	06	03	03	--	**39**	**50**	**44-56**
Laboratory Course (LBC)	--	--	02	03	02	02	02	--	**11**		
Program Elective (PEC)	--	--	--	--	03	03	06	03	**15**	**15**	**20**
Multidisciplinary Minor (MDM)	--	--	03	03	03	04	--	--	**13**	**13**	**14**
Multidisciplinary Laboratory Course (MDL) †	--	--	--	--	01	--	--	--	**01**	**01**	
Open Elective (OEC)	--	--	--	--	--	--	03	03	**06**	**06**	**08**
Skill Enhancement Course (SEC)	01	01	--	--	--	--	--	--	**02**	**08**	**08**
Skill Based Laboratory (SBL)	--	--	02	02	--	02	--	--	**06**		
Ability Enhancement Course (AEC)	--	03	--	--	02	--	--	--	**05**	**05**	**04**
Humanities Social Sciences and Management (HSS)	--	--	02	--	02	--	02	--	**06**	**06**	**04**
Indian Knowledge System (IKS)	--	02	--	--	--	--	--	--	**02**	**02**	**02**
Value Education Course (VEC)	02	--	--	02	--	--	--	--	**04**	**04**	**04**
Experiential Learning Course (ELC)	--	--	--	--	--	02	--	--	**02**	**02**	**04**
Mini Project (MNP)	--	--	01	01	01	01	--	--	**04**	**10**	**04**
Major Project (MJP)	--	--	--	--	--	--	02	04	**06**		
Internship (INT)	--	--	--	--	--	--	--	08	**08**	**08**	**12**
Liberal Learning Course (LLC)	--	--	--	--	--	02	--	---	**02**	**02**	**04**
Total Credits	**21**	**22**	**24**	**24**	**20**	**19**	**18**	**18**	**166**	**166**	**160-176**

† NOTE: The Multidisciplinary Laboratory Course can be moved to the sixth semester if the department prefers.

C Curriculum Structure and Examination Scheme for B. Tech in Computer Engineering

(FY and SY with Effect from AY 2024-2025)
Curriculum Structure – FY Semester-I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
BSC101	Engineering Mathematics I	3	--	1	3	--	1	4
BSC102	Engineering Physics-I	2	--	--	2	--	--	2
BSC103	Engineering Chemistry-I	2	--	--	2	--	--	2
ESC101	Engineering Mechanics	3	--	--	3	--	--	3
ESC102	Basic Electrical Engineering	2	--	--	2	--	--	2
BSL101	Engineering Physics-I Laboratory	--	1	--	--	0.5	--	0.5
BSL102	Engineering Chemistry-I Laboratory	--	1	--	--	0.5	--	0.5
ESL101	Engineering Mechanics Laboratory	--	2	--	--	1	--	1
ESL102	Basic Electrical Engineering Laboratory	--	2	--	--	1	--	1
ESL103	Programming Laboratory-I (C)	--	2*+2	--	--	2	--	2
SEC101	Basic Workshop Practice-I	--	2	--	--	1	--	1
VEC101	Universal Human Values	2	--	--	2	--	--	2
	Total	**14**	**12**	**1**	**14**	**6**	**1**	**21**

*** Instructions should be conducted for the entire class.**

NOTE 1: Compulsory Non-Credit Activities: Participation and/or coordination of co-curricular and extra-curricular events at the Institute or Department level is mandatory for all students from semesters 1 to 8 as part of non-credit liberal education. Please consult the department's Curriculum Book for more information. These activities do not yield credits. Upon successful participation or organization of activities, a certificate will be awarded at the conclusion of semester 8.

NOTE 2: Please note that during semesters 1 to 8 some of the non-technical courses such as Humanities Social Sciences and Management (HSSM), Open Electives (OE), Value Education Course (VEC), and Liberal Learning Course (LLC) may be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.

Examination Scheme – FY Semester-I

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC101	Engineering Mathematics-I	20+25@	30	50	1.5	2	125
BSC102	Engineering Physics-I	15	20	40	1.0	1.5	75
BSC103	Engineering Chemistry-I	15	20	40	1.0	1.5	75
ESC101	Engineering Mechanics	20	30	50	1.5	2	100
ESC102	Basic Electrical Engineering	15	20	40	1.0	1.5	75
BSL101	Engineering Physics-I Laboratory	25	--	--	--	--	25
BSL102	Engineering Chemistry-I Laboratory	25	--	--	--	--	25
ESL101	Engineering Mechanics Laboratory	25	--	--	--	--	25
ESL102	Basic Electrical Engineering Laboratory	25	--	25	--	--	50
ESL103	Programming Laboratory-I (C)	50	--	50	--	--	100
SEC101	Basic Workshop Practice-I	50	--	--	--	--	50
VEC101	Universal Human Values	50	--	--	--	--	50
	Total	**360**	**120**	**295**	**--**	**--**	**775**

$Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – FY Semester-II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
BSC204	Engineering Mathematics-II	3	--	1	3	--	1	4
BSC205	Engineering Physics-II	2	--	--	2	--	--	2
BSC206	Engineering Chemistry-II	2	--	--	2	--	--	2
AEC201	Professional Communication and Ethics-I	2	2	--	2	1	--	3
ESC203	Basic Electronics Engineering	2	--	--	2	--	--	2
BSL203	Engineering Physics-II Laboratory	--	1	--	--	0.5	--	0.5
BSL204	Engineering Chemistry-II Laboratory	--	1	--	--	0.5	--	0.5
ESL204	Engineering Graphics Laboratory	--	2*+2	--	--	2	--	2
ESL205	Programming Laboratory-II (Java)	--	2*+2	--	--	2	--	2
ESL206	Basic Electronics Engineering Laboratory	--	2	--	--	1	--	1
SEC202	Basic Workshop Practice-II	--	2	--	--	1	--	1
IKS201	Indian Knowledge System	2	--	--	2	--	--	2
	Total	**13**	**16**	**1**	**13**	**8**	**1**	**22**

*** Instructions should be conducted for the entire class.**

Examination Scheme – FY Semester-II

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC204	Engineering Mathematics-II	20+25@	30	50	1.5	2	125
BSC205	Engineering Physics-II	15	20	40	1.0	1.5	75
BSC206	Engineering Chemistry-II	15	20	40	1.0	1.5	75
AEC201	Professional Communication and Ethics-I	50	--	--	--	--	50
ESC203	Basic Electronics Engineering	15	20	40	1.0	1.5	75
BSL203	Engineering Physics-II Laboratory	25	--	--	--	--	25
BSL204	Engineering Chemistry-II Laboratory	25	--	--	--	--	25
ESL204	Engineering Graphics Laboratory	50	--	50	--	--	100
ESL205	Programming Laboratory-II (Java)	50	--	50	--	--	100
ESL206	Basic Electronics Engineering Laboratory	25	--	25	--	--	50
SEC202	Basic Workshop Practice-II	50	--	--	--	--	50
IKS201	Indian Knowledge System	50	--	--	--	--	50
	Total	**415**	**90**	**295**	--	--	**800**

$Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – SY Semester-III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPCC301	Engineering Mathematics-III	3	--	1	3	--	1	4
CEPCC302	Discrete Structures and Graph Theory	3	--	1	3	--	1	4
CEPCC303	Data Structures	3	--	--	3	--	--	3
CEPCC304	Database Management System	3	--	--	3	--	--	3
XXMDM301Y**	----	3	--	--	3	--	--	3
CELBC301	Data Structures Laboratory	--	2	--	--	1	--	1
CELBC302	Database Laboratory	--	2	--	--	1	--	1
CESBL301	Python Programming Laboratory	--	4	--	--	2	--	2
CEMNP301	Mini Project-1A	--	3	--	--	1	--	1
HSS301	Product Design	2	--	--	2	--	--	2
	Total	**17**	**11**	**2**	**17**	**5**	**2**	**24**

**Four Theory courses (Three 3-credit and one 4-credit) and one Laboratory course (1-credit) offered by other department has to be taken by Computer Engineering students, to complete the 14-credit requirement of MDM.

Examination Scheme – SY Semester-III

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPCC301	Engineering Mathematics-III	20+25@	30	50	1.5	2	125
CEPCC302	Discrete Structures and Graph Theory	20+25@	30	50	1.5	2	125
CEPCC303	Data Structures	20	30	50	1.5	2	100
CEPCC304	Database Management System	20	30	50	1.5	2	100
XXMDM301Y	----	20	30	50	1.5	2	100
CELBC301	Data Structures Laboratory	25	--	25	--	--	50
CELBC302	Database Laboratory	25	--	25	--	--	50
CESBL301	Python Programming Laboratory	50	--	50	--	--	100
CEMNP301	Mini Project-1A	50	--	--	--	--	50
HSS301	Product Design	50	--	--	--	--	50
	Total	**350**	**150**	**350**	--	--	**850**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – SY Semester-IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPCC405	Engineering Mathematics-IV	3	--	1	3	--	1	4
CEPCC406	Analysis of Algorithms	3		--	3	--	--	3
CEPCC407	Operating System	3	--	--	3	--	--	3
CEPCC408	Computer Network	3	--	--	3	--	--	3
XXMDM402Y	----	3	--	--	3	--	--	3
CELBC403	Analysis of Algorithms Laboratory	--	2	--	--	1	--	1
CELBC404	Operating System Laboratory	--	2	--	--	1	--	1
CELBC405	Computer Network Laboratory	--	2	--	--	1	--	1
CESBL402	Web Development Laboratory	--	4	--	--	2	--	2
CEMNP402	Mini Project-1B	--	3	--	--	1	--	1
VEC402	Environment and Sustainability	2	--	--	2	--	--	2
	Total	**17**	**13**	**1**	**17**	**6**	**1**	**24**

Examination Scheme – SY Semester-IV

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPCC405	Engineering Mathematics-IV	20+25@	30	50	1.5	2	125
CEPCC406	Analysis of Algorithms	20	30	50	1.5	2	100
CEPCC407	Operating System	20	30	50	1.5	2	100
CEPCC408	Computer Network	20	30	50	1.5	2	100
XXMDM402Y	----	20	30	50	1.5	2	100
CELBC403	Analysis of Algorithms Laboratory	25	--	25	--	--	50
CELBC404	Operating System Laboratory	25	--	25	--	--	50
CELBC405	Computer Network Laboratory	25	--	25	--	--	50
CESBL402	Web Development Laboratory	50	--	50	--	--	100
CEMNP402	Mini Project-1B	50	--	50	--	--	100
VEC402	Environment and Sustainability	50	--	--	--	--	50
	Total	**350**	**150**	**425**	--	--	**925**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

@For continuous assessment of tutorials.

Curriculum Structure – TY Semester-V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPCC509	Theoretical Computer Science	3	--	--	3	--	--	3
CEPCC510	Software Engineering	3	--	--	3	--	--	3
XXMDM503Y	----	3	--	--	3	--	--	3
CEPEC501Y	Program Elective-I	3	--	--	3	--	--	3
CELBC506	Software Engineering Laboratory	--	2	--	--	1	--	1
CELBC507	Application Development Laboratory	--	2	--	--	1	--	1
XXMDL501Y	----	--	2	--	--	1	--	1
AEC502	Professional Communication and Ethics-II	1	2	--	1	1	--	2
CEMNP503	Mini Project-2A	--	3	--	--	1	--	1
HSS502	Entrepreneurship	2	--	--	2	--	--	2
	Total	**15**	**11**	**--**	**15**	**5**	**--**	**20**

NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree programs.

Program Elective-I:

Every student is required to take Program Elective for Semester V. Students can take this course from the following list of Program Elective-I.

Program Elective-I	
CEPEC5011	Data Mining & Business Intelligence
CEPEC5012	Advanced Database Systems
CEPEC5013	Computer Graphics and Animation
CEPEC5014	Distributed Computing

Examination Scheme – TY Semester-V

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid - Sem	End-Sem	
CEPCC509	Theoretical Computer Science	20	30	50	1.5	2	100
CEPCC510	Software Engineering	20	30	50	1.5	2	100
XXMDM503Y	----	20	30	50	1.5	2	100
CEPEC501Y	Program Elective-I	20	30	50	1.5	2	100
CELBC506	Software Engineering Laboratory	25	--	25	--	--	50
CELBC507	Application Development Laboratory	25	--	25	--	--	50
XXMDL501Y	----	25	--	25	--	--	50
AEC502	Professional Communication and Ethics-II	50	--	--	--	--	50
CEMNP503	Mini Project-2A	50	--	--	--	--	50
HSS502	Entrepreneurship	50	--	--	--	--	50
Total		**305**	**120**	**275**	--	--	**700**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – TY Semester-VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPCC611	Cryptography and System Security	3		--	3	--	--	3
XXMDM604Y	---	4		--	4	--	--	4
CEPEC602Y	Program Elective-II	3	--	--	3	--	--	3
CELBC608	System Security Laboratory	--	2	--	--	1	--	1
CELBC609	IOT & Cloud Computing Laboratory	--	2	--	--	1	--	1
CESBL603	Full Stack Development Laboratory	--	4	--	--	2	--	2
CEMNP604	Mini Project-2B	--	3	--	--	1	--	1
ELC601	Research Methodology	2	--	--	2	--	--	2
LLC601Y*	Liberal Learning Course	2	--	--	2	--	--	2
	Total	**14**	**11**	**--**	**14**	**5**	**--**	**19**

NOTE: Students who choose not to pursue Honours or Minor are welcome to register for the initial two courses of the fifth and sixth semesters' Honours or Minor track in 'Audit' mode (AU). This allows them to explore the course material without the expectation of earning a letter grade. Upon fulfilling the requirements in 'Audit' mode, their participation will be acknowledged on the grade sheet. Audit courses are excluded from grade point averages and have no impact on SGPI/CGPI calculations. For more information on Honours and Minor track courses, please refer to the Institute Handbook for Honours/Minor/Honours in Research degree prorams.

***Liberal Learning Course:**

Every student should take Liberal Learning Course for Semester VI. Students can take this course from the following list of Liberal Learning Courses.

Liberal Learning Courses	
Course Code	**Course Name**
LLC6011	**Art of Living**
LLC6012	**Yoga and Meditation**
LLC6013	**Health and Wellness**
LLC6014	**Diet and Nutrition**
LLC6015	**Personality Development**

Program Elective-II:

Every student is required to take Program Elective for Semester VI. Students can take this course from the following list of Program Elective-II.

Program Elective-II	
CEPEC6021	Machine Learning ##
CEPEC6022	Big Data Analytics
CEPEC6023	Advanced Networks
CEPEC6024	High Performance Computing

Students who opted the AIML as Honours/Minor vertical should not opt Machine Learning as Program Elective-II.

Examination Scheme – TY Semester-VI

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem. Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPCC611	Cryptography and System Security	20	30	50	1.5	2	100
XXMDM604Y	---	20	30	50	1.5	2	100
CEPEC602Y	Program Elective-II	20	30	50	1.5	2	100
CELBC608	System Security Laboratory	25	--	25	--	--	50
CELBC609	IOT & Cloud Computing Laboratory	25	--	25	--	--	50
CESBL603	Full Stack Development Laboratory	50	--	50	--	--	100
CEMNP604	Mini Project-2B	50	--	50	--	--	100
ELC601	Research Methodology	50	--	--	--	--	50
LLC601Y	Liberal Learning Course	50	--	--	--	--	50
	Total	**310**	**90**	**300**	--	--	**700**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – B. Tech Semester-VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPCC712	Artificial Intelligence	3	--	--	3	--	--	3
CEPEC703Y	Program Elective-III	3	--	--	3	--	--	3
CEPEC704Y	Program Elective-IV	3	--	--	3	--	--	3
OEC701Y	Open Elective-I	3	--	--	3	--	--	3
CELBC710	Computational Intelligence Laboratory	--	2	--	--	1	--	1
CELBC711	Data Engineering Laboratory	--	2	--	--	1	--	1
CEMJP701	Major Project-A	--	6	--	--	2	--	2
HSS703	Financial Planning	2	--	--	2	--	--	2
Total		**14**	**10**	**--**	**14**	**4**	**--**	**18**

Program Elective-III & IV:

Every student is required to take two Program Electives for Semester VII. Students can take this course from the following list of Program Elective-III & Program Elective-IV.

Program Elective-III	
CEPEC7031	Deep Learning ##
CEPEC7032	Natural Language Processing
CEPEC7033	UI/UX
CEPEC7034	Advance Algorithms

Students who opted the AIML as Honours/Minor vertical should not opt Deep Learning as Program Elective-III.

Program Elective-IV	
CEPEC7041	Applied Data Science
CEPEC7042	Blockchain ##
CEPEC7043	Adhoc Networks
CEPEC7044	Compiler Design

Students who opted the Blockchain as Honours/Minor vertical should not opt Blockchain as Program Elective-IV.

Open Elective-I:
Every student is required to take one Open Elective for Semester VII. Students can take this course from the following list of Open Elective-I.

Course Code	Open Elective-I
OEC7011	Product Lifecycle Management
OEC7012	Reliability Engineering
OEC7013	Management Information System
OEC7014	Design of Experiments
OEC7015	Operation Research
OEC7016 @@	Cyber Security and Laws
OEC7017	Disaster Management and Mitigation Measures
OEC7018	Energy Audit and Management
OEC7019	Development Engineering

@@ Students who opted for Honours/Minor vertical as Cybersecurity should not opt Cybersecurity and Laws from the Open Elective-I list.

Examination Scheme – B. Tech Semester-VII

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPCC712	Artificial Intelligence	20	30	50	1.5	2	100
CEPEC703Y	Program Elective-III	20	30	50	1.5	2	100
CEPEC704Y	Program Elective-IV	20	30	50	1.5	2	100
OEC701Y	Open Elective-I	20	30	50	1.5	2	100
CELBC710	Computational Intelligence Laboratory	25	--	25	--	--	50
CELBC711	Data Engineering Laboratory	25	--	25	--	--	50
CEMJP701	Major Project-A	50	--	--	--	--	50
HSS703	Financial Planning	50	--	--	--	--	50
	Total	**230**	**120**	**250**	--	--	**600**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

Curriculum Structure – B. Tech Semester-VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEPEC805Y	Program Elective-V	3	--	--	3	--	--	3
OEC802Y	Open Elective-II	3	--	--	3	--	--	3
CEMJP802	Major Project-B	--	12	--	--	4	--	4
INT801	Internship~	--	--	--	--	8	--	8
	Total	**6**	**12**	**--**	**6**	**12**	**--**	**18**
~ Students have the opportunity to engage in a three-month internship within industry, research organizations, foreign universities, or internal internship for research and product development during the 8th semester, provided they meet the semester requirements and receive approval from the institute.								

Program Elective-V:

Every student is required to take Program Elective for Semester VIII. Students can choose Program Elective - V, from one of the domains listed below. The list of courses within the individual domain will be made available before the course registration.

Program Elective-V	
CEPEC8051	Social Network Data Analytics
CEPEC8052	Software Development
CEPEC8053	Network and Security
CEPEC8054	Machine Intelligence

Open Elective-II:

Every student is required to take one Open Elective for Semester VIII. Students can take this course from the following list of Open Elective-II.

Course Code	Open Elective-II
OEC8021	Project Management
OEC8022	Finance Management
OEC8023	Entrepreneurship Development and Management
OEC8024	Human Resource Management
OEC8025	Professional Ethics and CSR
OEC8026	Circular Economy
OEC8027	IPR and Patenting
OEC8028	Digital Business Management
OEC8029	Environmental Management

Examination Scheme – B. Tech Semester-VIII

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPEC805Y	Program Elective-V	20	30	50	1.5	2	100
OEC802Y	Open Elective-II	20	30	50	1.5	2	100
CEMJP802	Major Project-B	50	--	50	--	--	100
INT801	Internship	50	--	50	--	--	100
Total		**140**	**60**	**200**	--	--	**400**

$ Please refer to the Syllabus for guidelines on in-semester assessments for both theory and laboratory courses.

NOTE: Please note that due to the internship requirement in the 8th semester, theory courses during this semester will be conducted either online synchronously or asynchronously. For more information, please consult the curriculum book of your respective department.

D. Multidisciplinary Minor Courses Offered by the Department for the Other Program Students

Curriculum Structure for MDM Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
CEMDM301	Data Structures and Algorithms	3	--	--	3	--	--	3
CEMDM402	Database Management Systems	3	--	--	3	--	--	3
CEMDM503	Cloud computing	3	--	--	3	--	--	3
CEMDM604	Soft Computing	4	--	--	4	--	--	4
CEMDL601	Machine Learning Laboratory	--	2	--	--	1	--	1
	Total	**13**	**2**	**--**	**13**	**1**	**--**	**14**

Examination Scheme for MDM Courses

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEMDM301	Data Structures and Algorithms	20	30	50	1.5	2	100
CEMDM402	Database Management Systems	20	30	50	1.5	2	100
CEMDM503	Cloud computing	20	30	50	1.5	2	100
CEMDM604	Soft Computing	20	30	50	1.5	2	100
CEMDL601	Machine Learning Laboratory	25	--	25	--	--	50
	Total	**105**	**120**	**225**	**--**	**--**	**450**

E. Honours, Minor, and Honours in Research Degree Program

The Honours, Minor, and Honours in Research degree programs aim to empower students by offering specialized courses/research internships or projects in emerging fields of their interest, thus enhancing their proficiency in those areas. Students who achieve a CGPI of 7.5 or higher by the end of the fourth semester are eligible to pursue an additional 18 credits from the fifth to eighth semesters to qualify for a B. Tech degree with Honours, Minor, or Honours in Research designation. Students need to refer to the Institute level Handbook for Honours/Minor/Honours in Research Degree Programs for further details.

F. Third Year Syllabi

Course Type	Course Code	Course Name	Credits
PCC	CEPCC509	THEORETICAL COMPUTER SCIENCE	03

Examination Scheme					
Distribution of Marks			**Exam Duration (Hrs.)**		**Total Marks**
In-semester Assessment		**End Semester Examination (ESE)**			
Continuous Assessment	**Mid-Semester Exam (MSE)**		**MSE**	**ESE**	
20	30	50	1.5	2	100

Pre-requisite:

NIL

Program Outcomes addressed:

1. PO1- Engineering knowledge
2. PO2- Problem analysis
3. PO3- Design/development of solutions
4. PO4- Conduct investigations of complex problems
6. PO9- Communication
7. PO11- Life-long learning

Course Objectives:

1. To familiarize with the fundamentals of TCS.
2. To develop the understanding of theoretical design of deterministic and non- deterministic finite automata, push down automata and Turing machine.
3. To equip the students with the concept of Context free grammar to recognize the language.
4. To introduce various properties of formal language.
5. To conceptualize the concept of Undecidability.

Module	Details	Hrs.
	Course Introduction The theory of computation plays a crucial role in helping engineers in the industry by providing a foundational understanding of how computational systems work. It equips engineers with the knowledge to design efficient algorithms, optimize processes, and build scalable systems. By understanding concepts like automata theory, formal languages, and complexity theory, engineers can better analyze the capabilities and limitations of different computational models, such as finite automata, pushdown automata, and Turing machines. This allows them to create software and hardware solutions that are both robust and efficient.	**01**
01.	**Basic concept and Finite Automata** ***Learning Objective****:* *To familiarize the concepts of fundamentals of TCS and theoretical design of deterministic and non- deterministic finite automata*	**7-9**

	Contents: Importance of TCS, Alphabets, Strings, Languages Finite Automata (FA) and Finite State machine (FSM). 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.	
	Self-Learning Topics: *Efficiency in automata-based pattern recognition systems*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply engineering fundamentals to represent alphabets and strings to construct and analyze languages. (1.3.1)* *LO 1.2: Design NFA and DFA by generating potential solutions to accept strings containing a specific substring over a given input alphabet, ensuring they meet functional requirements. (P.I.-3.2.2)* *LO1.3: Apply the principal of computer science to construct Moore and Mealy machine to generate output for a given problem. (1.4.1)* *LO 1.4 Validate the correctness of Moore machine converting it to an equivalent Mealy machine. (P.I.-3.4.3)*	
02.	**Regular Expression and Language** ***Learning Objective:*** *Conceptualize the concept of regular expression and regular language*	**8-10**
	Contents: Regular expression, Equivalence of Regular Expression and Finite Automata, Arden's Theorem, Regular Expression Applications, Regular Language (RL), Closure properties of RLs, Pumping lemma for RLs.	
	Self-Learning Topics: *Decision properties of RLs*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply engineering fundamental to derive and interpret regular expression. (1.3.1).* *LO 2.2: Identify and apply regular expressions and grammars to recognize and analyze regular languages for computational problems. (P.I.-2.3.2)* *LO 2.3: Apply the knowledge of regular expression to understand its use in real world applications. (2.4.1)* *LO 2.3: Apply theory and principles to recall and validate closure properties in computational systems. (P.I.-1.4.1)*	
03.	**Grammar** ***Learning Objective:*** *Expected to conceptualize Context free grammar to recognize the language*	**8-10**
	Content Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA. 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), pumping lemma for CFG, Chomsky Hierarchy	
	Self-Learning Topics: *closure properties of context free language*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply the knowledge of discrete structure and construct Context-Free Languages by leveraging Context-Free Grammars (CFG) to solve computational problems. (P.I.-1.1.1)* *LO 3.2: Apply engineering fundamentals in simplifying and normalizing grammars to improve the accuracy and efficiency of language representation benefitting application in parsing, compiler design and natural language processing. (P.I.-1.3.1) (P.I.11.1.1)* *LO 3.3: Identify the characteristics and functionalities of language classes in the Chomsky Hierarchy, to understand computational power. (P.I.-2.2.2)* *LO 3.4: Build parse trees to address real world problem such as syntax validation in programming language and data verification. (P.I.-2.2.3) (P.I.-11.2.2) (P.I.-11.2.2)* *(syntax checking of programming language, data validation)*	
04.	**Push down Automata** ***Learning Objectives:*** *Familiarize with the theoretical design of pushdown automata*	**8-10**
	Contents: Definition, Language of PDA, PDA as generator, decider and acceptor of CFG, Deterministic PDA, Non-Deterministic PDA, Construction of PDA to CFG, Applications of PDA	
	Self-Learning Topics: *Multistack DPDA*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply engineering knowledge to construct PDA for the given language (1.3.1)* *LO 4.2: Apply Pushdown Automata(PDA) as a generator to model and construct structured language representation, demonstrating fundamental engineering knowledge in formal language (1.4.1).* *LO 4.3: Apply Pushdown Automata(PDA) as a decider and acceptor to analyze and validate programming language syntax, ensuring accurate parsing and error detecting in program and analysis. (2.4.4)* *LO 4.4: Apply pushdown automata (PDA) principal to design and develop efficient syntax parsers and effectively communicate formal solutions. (P.I- 3.2.1, P.I-9.2.1, P.I-9.2.2, P.I-11.1.2)* *LO 4.5: Construct deterministic and non-deterministic PDAs and explore multiple design solution to fulfill functional requirement. (3.2.2)*	
05.	**Turing Machine** ***Learning Objective:*** *Expected to design and employ the concept of Turing Machine and its variants.*	**5-7**
	Contents: Definition, Design of TM as generator, decider and acceptor. Variants of Turing machine: Multitrack, Multi-tape, Universal TM, Application, power and limitations.	
	Self-Learning Topics: *Nil*	

	Learning Outcomes : *A learner will be able to* *LO 5.1: Select and apply appropriate procedure for designing Turing machine as generators, deciders and acceptors to effectively model computational processes. (4.1.2)* *LO 5.2: Apply the knowledge of variants of Turing machine to solve real world problems (P.I.-2.2.4) (P.I.-6.4.2) (P.I.-11.2.2)* *(AI-powered chatbot, text editing software)* *LO 5.3: Design and implement a Universal Turing Machine by developing appropriate methodologies and procedures to simulate computation effectively. (P.I.-4.2.1)*	
6.	**Undecidability** ***Learning Objective:*** *Conceptualize the concept of Undecidability*.	**1-3**
	Contents: Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.	
	Self-Learning Topics: *P-NP problems*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply engineering fundamental to analyse recursive and recursively enumerable languages, determining their properties and implication in computational problem solving. (P.I-1.3.1)* *LO 6.2: Apply the theory and principal od decidability and undecidability to understand computational problem and determine whether they can be algorithmically solved. (P.I-1.4.1)* *LO 6.3: Identify exiting method to analyse the post correspondence problem and apply Rice's theorem, forming justified approximation and assumption to determine the decidability and complexity of computational problem.(PI-2.2.3)* *LO 6.4: Identify and explain the halting problem by analyzing processes, modules, and algorithms to understand its significance in computational systems. (P.I.-2.1.2)*	
	Course Conclusion A Theory of Computation course concludes by establishing a foundational understanding of what problems computers can and cannot solve, providing insights into the limits of computation and laying the groundwork for designing efficient algorithms and software by exploring theoretical models like automata, Turing machines, and computational complexity, ultimately allowing developers to identify solvable problems, analyze algorithm efficiency, and avoid attempting to solve computationally impossible tasks.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.2	Identify functionalities and computing resources.
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.3.2	Identify design constraints for required performance criteria.
2.4.1	Applies engineering mathematics to implement the solution.
2.4.4	Arrive at conclusions with respect to the objectives.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
3.4.3	Able to verify the functionalities and validate the design.
4.1.2	Able to choose appropriate procedure/algorithm, dataset and test cases.
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
11.1.1	Deliver effective oral presentations to technical and non-technical audiences
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to –

1. Apply the basic concept of theory of computation to construct and analyse language *(LO 1.1, LO 1.2)*
2. Identify the language and accordingly design and simplify the appropriate computational models such as FA, PDA, and Turing machines. *(LO 1.3, LO 1.4, LO 4.1, LO 4.2, LO 5.1, LO 5.2)*
3. Identify and convert the grammar in various normal forms like CNF and GNF. *(LO 3.1, LO 3.2, LO 3.3)*
4. Write regular expression, prove the closure property and the type of language using pumping lemma. *(LO 2.1, LO 2.2, LO 2.3, LO 3.4)*
5. Demonstrate the concept of decidability and undecidability with through live case study. *(LO 5.3, LO 6.1, LO 6.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPCC509.1	3	-	3	-	-	-	-	-	-	-	-
CEPCC509.2	3	3	-	-	-	-	-	-	-	-	-
CEPCC509.3	3	3	-	-	-	-	-	-	-	-	3
CEPCC509.4	3	3	3	3	-	-	-	-	3	-	3
CEPCC509.5	3	3	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**3**

Text Books :

1. John E Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "*Introduction to Automata Theory Languages and Computation*", 3rd Edition, Pearson Education, 2011.
2. Michel Sipser, "*Introduction to Theory of Computation*", 2nd Edition, Thomson, 2012

Reference Books :

1. Mishra and Chandrashekaran, "*Theory of Computer Science – Automata Languages and Computation*", 3rd Edition, PHI, 2009
2. K V N. Sunitha, N. Kalyani, "*Formal Languages and Automata Theory*", 1st Edition, TMH, 2010

Other Resources :

1. Web Reference: https://swayam.gov.in/nd1_noc19_cs79/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

One MCQ test as per GATE exam pattern / level: 05 Marks.
One Class test: 05 Marks.
One Team-Pair-Solo activity: 05 Marks.
Regularity and active participation: 05 Marks.

1. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PCC	CEPCC510	SOFTWARE ENGINEERING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESL205- Programming Laboratory –II (JAVA)
2. CESBL301- Python Programming Laboratory

Program Outcomes addressed:

PO 1- Engineering knowledge

PO 2- Problem analysis

PO 3 -Design/Development of Solutions

PO 4 - Conduct Investigations of Complex problems.

PO 6 -The Engineer and The World

PO 7- Ethics

PO 10 - Project Management and Finance

PO 11 -Life-long learning

Course Objectives:

1. To provide the detailed knowledge in the arena of software engineering.
2. To relate the principles of design, estimation and testing for software project development.
3. To familiarize students with the Quality Assurance and maintenance of the software.
4. To introduce the risk monitoring, reengineering and reverse engineering concepts.
5. To familiarize students with the need of software configuration management and SCM process.

Module	Details	Hrs
	Course Introduction Software Engineering course covers essential principles for designing computer software, crucial for software development and testing.	**01**

01.	**Software Engineering and Process Models.** ***Learning Objectives:*** *To study the basics and fundamentals of software engineering and process framework activities with the advanced trends in software engineering.*	**7-9**
	Contents: 1.1 Nature of Software-Defining software, software application domains, changing nature of software. 1.2 Software Engineering- The Software Process: -The process framework, Umbrella Activities, 1.3 Software Process Structure- A generic process model, defining a Task Set, Identifying a Task set, Process Patterns, CMM levels 1.3 Process Models-Prescriptive Process Models: - Waterfall model, Incremental models, evolutionary models, concurrent models 1.4 Agile Development- What is agility? Agility and the cost of change, what is an agile process? Agile Process models: - XP, Scrum 1.5 Modern Development Practices: What is engineering Devops?, Nine Pillars of Engineering Devops.	
	Self-Learning Topics: *Kanban agile process model.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply engineering fundamentals of software to identify the need of software engineering process and framework activities for the software project development. (P.I.-1.3.1).* *LO 1.2: Select the best agile model for a given scenario. (P.I.-2.2.5).* *LO 1.3: Apply computer engineering fundamentals to identify the differences between various software process models and their applicability. (P.I.-1.4.1)* *LO 1.4: Recognize the cultural, technical, and organizational changes that DevOps brings to software engineering. (P.I.-2.2.4), (P.I.-11.2.2)*	
02.	**Modeling** ***Learning Objectives:*** *To define concepts of requirement engineering and design different requirement models.*	**6-8**
	Contents: 2.1 Understanding the Requirements: Requirements Engineering, Eliciting Requirements, Negotiating Requirements, requirements Monitoring, Validating Requirements. 2.2 Requirement Modeling: Scenario Based Methods, class based Methods, Data Flow Diagram, SRS (Software Requirement Specification) document format (IEEE)	
	Self-Learning Topics: *CRC Modeling.* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Check out the various functions and features of software to be developed and categorize them based on their requirements. (P.I.-2.2.2).* *LO 2.2: Identify the process of requirement engineering for effective software design on a given problem statement. (P.I.-2.1.2)* *LO2.3: Design a requirement model for a given case study. (P.I.-3.2.1), (P.I.- 11.3.1)* *LO2.4: Design a software specification based on given requirement/data. (P.I.- 3.1.6), (P.I.- 11.1.1)*	

03.	**Software Design** ***Learning Objectives:*** *To design and apply design principles for the development of software projects.*	**7-9**
	Contents 3.1 Design Concepts: Design within the context of software engineering, the design process, design concepts, design model. 3.2 Architectural Design: Software Architecture, Architectural Styles, Architectural designs. 3.3 Component Level Design: What is a component? Designing class- based components, Conducting component level Design. 3.4 User Interface Design: Usability of Interactive Systems, Guidelines, Principles, and Theories, Development Processes, Interaction Styles 3.5 Introduction to ethical design: the need for ethics in design, ethical design best practices.	
	Self-Learning Topics: *Developing a Swim Lane Diagram*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Assess the architectural considerations of a given application so as to meet its functional requirements. (P.I.-2.1.1)* *LO 3.2: Appraise the architecture styles and architecture design for the overall system and interaction with the external entities ethically. (P.I.-2.3.1), (P.I.-7.1.1)* *LO 3.3: Determine effects of modularity on the overall development of sustainable software design. (P.I.-3.4.2), (P.I.-6.3.2)* *LO 3.4: Implement an ethical design of a UI for a given case study using management techniques for sustainable development. (P.I.-3.1.1), (P.I.- 6.4.1), (P.I.-7.2.2)*	
04.	**Software Estimation Metrics and Managing Software Projects,** ***Learning Objectives:*** *To estimate the cost and effort, provide an overview of Software Metrics, and perform project scheduling.*	**7-9**
	Contents 4.1 Product Metrics: A Framework for Product Metrics, Metrics for the Requirement Model. 4.2 Process and Project Metrics: Metrics in the process and Project Domains, Software Measurement, Integrating Metrics within the software process. 4.3 Estimation for Software projects: Software Scope and feasibility, Resources, Decomposition Techniques: LOC-Based Estimation and FP-Based Estimation, Empirical estimation Model (COCOMO II). 4.4 Project Management Concepts: Management Spectrum, people, product, process. 4.5 Project Scheduling: Basic Concepts, project scheduling, defining a task set for the software project, Scheduling: - Time-line chart, tracking the schedule, earned value analysis.	

	Self-Learning Topics: *Estimation for Agile Development.* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Estimate cost and effort using various software estimation techniques. (P.I.-2.1.1), (P.I.-10.1.2)* *LO 4.2: Identify the tasks and resources required to implement the given software project. (P.I.-2.2.2), (P.I.-10.3.1)* *LO 4.3: Construct a timeline chart to schedule the required tasks that are planned for the completion of a software project. (P.I.-3.1.1), (P.I.-10.3.2)* *LO 4.4: Utilizing the project management spectrum for the effective implementation of a software project explore various design alternatives. (P.I.-3.2.1), (P.I-10.2.1)*	
05.	**Software Testing** ***Learning Objectives:*** *To apply testing principles along with the maintenance of software projects.* **Contents** 5.1 Software testing Strategies: A strategic approach to software testing, Test strategies for Conventional software: - Unit Testing, Integration testing, Validation Testing, System testing. 5.2 Testing Conventional Applications: White-box testing: Basis path, Control structure testing black-box testing: Graph based, Equivalence, Boundary Value . ***Self-Learning Topics:*** *Four-step strategy for real-time software testing.* ***Learning Outcomes:*** *A learner will be able to* *LO5.1: Identify an appropriate testing strategy to create test cases for a given software application. (P.I.-4.1.2), (P.I.-6.3.1)* *LO5.2: Use a suitable white box testing and black box technique to derive test cases for ensuring validity of internal data structures. (P.I.-4.3.1), (P.I.-6.4.2).*	**4-6**
06.	**Quality Assurance, Software Configuration Management, Maintenance and Reengineering** ***Learning Objectives:*** *To effectively plan and perform various aspects of software including Risk analysis, Quality assurance, management and maintenance.* **Contents:** 6.1 Quality Concepts, Review Techniques, Software Quality Assurance, SQA metrics 6.2 Software Configuration Management: -SCM Repository, SCM Process 6.3 Risk Management: Reactive versus Proactive risk strategies, Risk Identification, Risk projection, RMMM and RMMM plan 6.4 Introduction to sustainable and Green software development: code efficiency, Hyper efficient code, Performance versus efficiency versus greenness, Operational efficiency, GSMM (Green Software Maturity Matrix) ***Self-Learning Topics:*** *Business process Reengineering Model*	**6-8**

	Learning Outcomes: *A learner will be able to* *LO6.1: Determine the need of SCM for a given project by stating various processes of SCM. (P.I.-2.1.2), (P.I.-11.2.2)* *LO6.2: Use an appropriate review for uncovering the errors and improving software quality. (P.I.-4.3.1), (P.I.-11.3.1)* *LO 6.3: Construct an RMMM plan to assist a project team in defining risks by assessing its impact and probability of occurrence. (P.I.-3.1.1), (P.I.-6.3.1)* *LO6.4: Apply principles of software maintenance in an effective way for sustainable software (P.I.-2.3.1), (P.I.-6.4.1)* *LO6.5: Identify the need of green software practices and explore the strategies to improve the sustainability of software systems. (P.I.-2.1.2) (P.I.-6.3.2)*	
	Course Conclusion In conclusion, software engineering aims to develop expertise in the project planning, requirements, design, testing and quality assurance needed for effective software development.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identifies processes/modules/algorithms/ of a computer-based system and parameters to solve a problem.
2.2.2	Identify functionalities and computing resources
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.1.6	Able to develop software requirement specifications (SRS).
3.2.1	Ability to explore design alternatives.
4.1.2	Ability to choose appropriate procedure/algorithm, data set and test cases
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
6.3.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
6.4.1	Describe management techniques for sustainable development
6.4.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives.
7.2.2	Examine and apply moral & ethical principles to known case studies

10.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project.
10.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations.
10.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
10.3.2	Use project management tools to schedule an engineering project so it is completed on time and on budget
11.1.1	Describe the rationale for the requirement for continuing professional development
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
11.3.1	Source and comprehend technical literature and other credible sources of information.
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Select the appropriate model of software process using basic fundamentals of software engineering.*(LO 1.1 ,LO 1.2, LO 1.3)*
2. Design and apply the requirement models for a given scenario.*(LO2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Develop software architecture using various design principles. *(LO 3.2, LO 3.3, LO 3.4)*
4. Identify the software estimation metrics and track the progress of the software project. *(LO 4.1, LO 4.2, LO 4.3)*
5. Apply testing principles for various softwares. *(LO 5.1, LO 5.2)*
6. Analyze the need for SCM and risks for mitigation to manage quality of the software. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPCC510.1	3	3	-	-	-	-	-	-	-	-	2
CEPCC510.2	-	3	3		-	-	-	-	-	-	3
CEPCC510.3	-	3	3	-	-	3	3	-	-	-	-
CEPCC510.4	-	3	3	-	-		-	-	-	3	-
CEPCC510.5	-	-		3	-	3	-	-	-	-	-
CEPCC510.6	-	3	2	2	-	3	-	-	-	-	3
Average	**3**	**3**	**3**	**3**	-	**3**	**3**	-	-	**3**	**3**

Text Books:

1. Software Engineering A Practitioner's Approach, Roger S. Pressman, 8th Edition, McGraw-Hill Publication.
2. The unified modeling language user guide, Grady Booch, James Rambaugh, Ivar Jacobson, 2nd edition, Pearson Education, 2005
3. Engineering Devops- A New Engineering Blueprint for Devops transformation-Marc Hornbeek Copyright © 2019 by Marc Hornbeek.
4. Building Green Software A Sustainable Approach to Software Development and Operations, Anne Currie, Sarah Hsu & Sara Bergman, O'Reilly Media, Copyright © 2024 WorkingProgram Ltd.
5. Designing the User Interface for effective human computer interaction, Ben Shneiderman, Catherine Plaisan, 4th Edition, Copyright ©2005 by Pearson Education, Inc
6. The Ethical Design Handbook was written by Trine Falbe, Kim Andersen, and Martin Michael Frederiksen; Published 2020 by Smashing Media AG, Freiburg, Germany.

Reference Books:

1. Fundamentals of Software Engineering, Rajib Mall, 5th edition, Prentice Hall India, 2014

Other Resources:

1. NPTEL Course: Software Engineering By Prof. Rajib Mall, IIT Kharagpur :- Web link- NPTEL

IN-SEMESTER ASSESSMENT (50 MARKS)

Continuous Assessment (20 Marks)

Suggested breakup of distribution

1. Assignment on live problems/ case studies: 10 marks
2. Orals/ Group discussion/ script writing/ public speaking/ technical report writing: 05 Marks
3. Regularity and active participation: 05 Marks

Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination(MSE) carrying 30% weightage, and the syllabus covered from MSE to ESE carrying 70% weightage

Course Type	Course Code	Course Name	Credits
PEC	CEPEC5011	DATA MINING & BUSINESS INTELLIGENCE	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC304 - Database Management System

Program Outcomes addressed:

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/development of solutions.
4. PO5: Engineering tool usage
5. PO9: Communication
6. PO11: Life-long learning

Course Objectives:

1. To build an understanding about the principles of Data warehousing, Data Mining and Business Intelligence
2. To foster comprehensive knowledge about the architecture of a Data Mining system
3. To familiarize the concepts of the various data pre-processing Methods
4. To gain knowledge of the supervised and unsupervised learning algorithms.
5. To impart skills to approach business problems analytically identifying opportunities to derive business value from data

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Module	Details	Hrs.
	Course Introduction Data mining and business intelligence (BI) are critical fields for computer engineering students, as they blend technical expertise with data-driven decision-making. Their significance stems from the growing role of data in every sector, enabling insights, optimizations, and innovation.	**01**

01.	**Overview and concepts of Data Warehousing and Business Analysis** ***Learning Objective:*** *Learner is expected to familiarize with the significance of Data Warehousing, DW schemas and OLAP operations.*	**5-7**
	Contents: Introduction to Data Warehouse, Need for data warehousing, data mart, Data Warehouse characteristics and architecture, Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. ETL process, OLTP versus OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
	Self-Learning Topics: *Updation to the dimension tables.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply engineering fundamentals to understand data warehouse architecture and need of creating data mart. (P.I.-1.3.1)* *LO 1.2: Apply theory and principles of data warehousing to understand dimensional modeling. (P.I.-1.4.1)* *LO 1.3: Evaluate the real-life problem statement. (P.I.-2.1.1)* *LO 1.4: Able to produce design of data warehouse for a real-life problem statement using star schema and snowflake schema (PI-3.4.2, 11.1.1, 11.2.2)* *LO 1.5: Identify the need of snowflake schema while designing data warehouse (PI-2.2.2)* *LO 1.6: Able to construct a data cube to analyze an open-ended problem by applying OLAP operations. (PI-3.2.1)*	
02.	**Introduction to Data Mining, Data Exploration and Data Pre-processing** ***Learning Objective:*** *To impart the importance of data mining principles, issues and its applications.*	**7-9**
	Contents: **Introduction to Data Mining:** Importance of Data Mining: Data Mining functionalities, Data mining architecture, KDD process, Applications of Data Mining. **Data Exploration:** Types of Attributes, Statistical Description of Data. **Data Pre-processing**: Why to pre-process data? Data cleaning: Missing Values, Noisy Data, Data Integration, Data Reduction: Attribute Subset Selection, Data Discretization: Normalization, Binning, Histogram Analysis, Data Visualization.	
	Self-Learning Topics: *Major issues in Data Mining, Data Mining Task Primitives*	

	Learning Outcomes: *A learner will be able to* *LO 2.1: Define Data mining and explain the importance, functionalities, architecture, and Knowledge Discovery in Databases (KDD) process. (P.I.-1.4.1)* *LO 2.2: Identify different types of data attributes and their characteristics. (P.I.-1.1.1)* *LO 2.3: Apply statistical tools and techniques to explore and interpret data effectively for meaningful insights. (P.I.: 2.2.2)* *LO 2.4: Demonstrate the use of different data preprocessing techniques such as data cleaning, integration, data discretization and reduction to improve data quality. (P.I.-2.1.2).*	
03.	**Mining frequent patterns and associations** ***Learning Objective:*** *To acquaint data mining principles for finding frequent patterns and association between items recorded in a transactional database*	**6-8**
	Contents: Introduction to Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from Frequent Itemset, Improving the Efficiency of Apriori . Mining Frequent Itemsets without candidate generation (FP growth approach)	
	Self-Learning Topics: *Mining Frequent Itemset using vertical data formats. Mining Multilevel Association Rules and Multidimensional Association Rules*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply the engineering knowledge to understand market basket analysis. (P.I.- 1.3.1,)* *LO 3.2: Apply the fundamentals of market basket analysis to identify the patterns in given scenario. (P.I.- 1.4.1,)* *LO 3.3: Identify different pattern mining methods used for discovering hidden information in data. (P.I.- 2.1.2).* *LO 3.4: Explore the functionality of different pattern mining methods. (P.I.- 3.2.1).* *LO 3.5: Demonstrate the use of pattern mining methods to find frequent itemsets and derive association rules from them. (P.I.- 3.4.2).* *LO 3.6: Compare different pattern mining to select the best for the given scenario. (PI-2.2.5)*	
04.	**Classification**	**7-9**
	Learning Objectives: *To familiarize with concept of data mining task classification and applying it to solve a supervised learning problem.*	

	Contents: What is classification? Classification methods: Decision tree, Naïve Bayes Classification. Introduction to evaluate the accuracy of a Classifier: Holdout, Random Sampling, Cross Validation, Bootstrap.	
	Self-Learning Topics: Introduction of Ensemble methods: Bagging, Boosting. ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Apply the engineering knowledge to understand concept of classification (P.I.-1.3.1)* *LO 4.2: Apply theory and principles of computer science to understand the significance of classification in data mining. (P.I.-1.4.1)* *LO 4.3: Identify different types of classifiers to perform classification task. (P.I.-2.1.2)* *LO 4.4: Construct a Decision Tree or Naïve Bayes classifiers for a given dataset. (P.I.-3.4.2)* *LO 4.5: Demonstrate the use of constructed model to classify unknown samples based on given attributes. (P.I.- 3.4.3)* *LO 4.6: Identify various classification model evaluation techniques and explain their importance in assessing model performance. (P.I-2.1.2)*	
05.	**Clustering** ***Learning Objective/s:*** *To get familiarize with the concept of data mining task clustering and applying it to solve a unsupervised learning problem*	**6-8**
	Contents: Types of data in Cluster analysis, Partitioning Methods (*k*-Means), Hierarchical Methods (Agglomerative, Divisive).	
	Self-Learning Topics: *Partitioning Method: k-Medoids Hierarchical method: BIRCH, Density based method: DBSCAN* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Apply the engineering knowledge to understand concept of clustering. (P.I.-1.3.1)* *LO 5.2: Apply theory and principles of computer science to understand the significance of clustering in data mining. (P.I.-1.4.1)* *LO 5.3: Identify different types of clustering methods to group given dataset. (P.I.-2.1.2)* *LO 5.4: Explore different clustering methods and its functionality. (P.I.- 3.2.1)* *LO 5.5: Demonstrate the use of clustering methods to classify a given dataset into meaningful groups. (P.I.- 3.4.2)* *LO 5.6: Compare the performance of clustering methods (k-Means, Agglomerative) based on evaluation measures such as within-cluster variance and dendrogram analysis. (P.I.-2.2.5)*	

06.	**Data Mining for Business Intelligence Applications** ***Learning Objective:*** *Learner is expected to apply BI to solve practical problems.*	**6-8**
	Contents: Introduction and overview of BI-Effective and timely decisions, Data Information and knowledge, BI Architecture, Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Market Segmentation, Telecommunication Industry, Banking and finance. Data Analytics life cycle : Introduction to Big data business analytics- State of the practice in analytics role of data scientists.	
	Self-Learning Topics: *Clickstream Mining, Retail industry, CRM, Epidemic prediction, Fake News Detection, Cyberbullying, Recommendation system, Sentiment Analysis etc*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply engineering fundamentals to understand BI Architecture and its components. (P.I.- 1.3.1)* *LO 6.2: Apply principles of computer science to understand the development of real life Business Intelligence systems. (P.I.-1.4.1, 11.1.1, 11.2.2)* *LO 6.3: Identify different Data Mining techniques used for Business Intelligence applications. (P.I.- 2.1.1)* *LO 6.4: Analyze the use of Data Mining techniques for Business Intelligence applications, explaining their significance and impact on decision-making. (P.I.- 2.2.3)* *LO 6.5: Visualize clustering results using appropriate data visualization tools to provide decision support using appropriate data visualization tools. (P.I. -5.1.1, 9.2.2)* *LO 6.6: Interpret visualized clustering results to gain insights and make decisions. (P.I. -5.2.2)*	
	Course Conclusion This course covers the fundamentals of storing, managing, and analyzing data to support business decision-making. It helps students understand data warehouse concepts, BI architecture, data mining techniques used to extract meaningful insights from data.	**01**
	Total	**45**

Performance Indicators:

P. I. No.	P. I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem.
2.1.1	Evaluate problem statements and identifies objectives.
2.1.2	Identify and analyze appropriate tools and techniques for a given engineering problem.

2.2.2 Identify functionalities and computing resources.

2.2.3 Identify existing solution/methods to solve the problem including forming justified approximations and assumptions.

2.2.5 Compare and contrast alternative solution processes to select the best process.

3.2.1 Able to explore design alternatives

3.4.2 Able to implement and integrate the modules.

3.4.3 Able to verify the functionalities and validate the design.

5.1.1 Identify modern engineering tools, techniques and resources for engineering activities.

5.2.2 Demonstrate proficiency in using discipline-specific tools.

9.2.2 Deliver effective oral presentations to technical and non-technical audiences

11.1.1 Describe the rationale for the requirement for continuing professional development.

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to –

1. Apply data warehouse concepts for dimensional modeling and analyze data using OLAP operations for real life applications. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5, LO 1.6)*
2. Apply data mining principles for data preprocessing, transformation, and exploration to analyze and enhance data quality. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Apply and analyze pattern mining and market basket analysis to discover associations, frequent itemsets, and recommend techniques for large-scale data challenges. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6)*
4. Apply and analyze classification, clustering techniques to discover hidden patterns in datasets. *(LO 2.2, LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6, LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)*
5. Analyze real life applications and business case studies to demonstrate the use of data warehousing and data mining techniques and tools for better decision-making and effectively communicate insights. (*LO 1.1, LO 2.1, LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, 6.6*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC5011.1	3	3	3	-	-	-	-	-	-	-	3
CEPEC5011.2	3	3	-	-	-	-	-	-	-	-	-
CEPEC5011.3	3	3	3	-	-	-	-	-	-	-	-
CEPEC5011.4	3	3	3	-	-	-	-	-	-	-	-
CEPEC5011.5	3	3	3	-	3	-	-	-	2	-	3
Average	**3**	**3**	**3**	-	**3**	-	-	-	**2**	-	**3**

Text Books:

1. Data Mining Concepts and Techniques, Han, Kamber, 3rd Edition.
2. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.
3. Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals, Paulraj Ponniah, Wiley Publications
4. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education
5. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis, Wiley India Publications.

Reference Books:

1. Data Mining, Vikram Pudi & Radha Krishna, Oxford Higher Education.
2. Reema Theraja, "Data warehousing", Oxford University Press 2009.
3. Data Mining Techniques, Michael Berry and Gordon Linoff, 2nd Edition Wiley Publications.,
4. G. Shmueli, N.R. Patel, P.C. Bruce, "Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", 2nd Edition, Wiley India.
5. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining", Morgan Kaufmann 3rd edition

Other References

1. https://www.coursera.org/specializations/data-mining
2. NPTEL Course: Data Mining by Prof. Pabitra Mitra, IIT Kharagpur Web Link- https://onlinecourses.nptel.ac.in/noc22_cs11/course

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

1. Two Class test: 05 marks each
2. Open book test/ Activity: 05 Marks
3. Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination(MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC5012	ADVANCE DATABASE SYSTEMS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC304 - Database Management System.

Program Outcomes addressed:

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/development of solutions.
4. PO5: Engineering Tools usage
5. PO8: Individual and Collaborative Team Work
6. PO9: Communication
7. PO11: Life-long learning.

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

Module	Details	Hrs
	Course Introduction Advanced database management systems are essential for handling large volumes of complex data securely, optimizing performance, and enabling scalability. Proficiency in these systems opens up diverse career opportunities in fields such as database administration, data engineering, and business intelligence, offering competitive skills and prospects for career advancement.	**01**
01.	**Database System Architectures** ***Learning Objective/s:*** *Expected to apply database concepts, architectures, and system designs to address diverse computational requirements and enhance data management efficiency.*	**4-5**
	Contents: Heterogeneous and homogeneous databases, Centralized and client-server architectures, Server system, Architectures, Parallel systems, Distributed systems.	
	Self-Learning Topics: *Distributed Catalogue Management*	

	Learning Outcomes: *A learner will be able to* *LO1.1. Apply engineering principles to understand database architectures and evolution, highlighting technological advances that drive continuous learning by analysing source technical information. (P.I.-1.3.1, PI-11.2.1 and PI-11.3.2)* *LO1.2. To apply computer engineering concepts to illustrate the database system architecture with operational details. (P.I.-1.4.1)* *LO1.3. To identify design constraint of the various database systems. (P.I.-2.3.2)* *LO1.4. Compare and contrast various database system to select the best for the given scenario (P.I. 2.2.5)*	
02.	**Querry Processing:** ***Learning Objective/s:*** *Expected to apply algorithmic techniques in query processing and optimization, including sorting and join operations, to improve the efficiency and reliability of database systems.*	**5-7**
	Contents: Steps for processing a query, Sorting, Join Operation, Nested Loop Join Block Nested Loop Join, Hash Join , Basics , Recursive portioning, Handling of overflow	
	Self-Learning Topics: *Query Processing in Memory*	
	Learning Outcomes: *A learner will be able to* *LO2.1. Apply Engineering knowledge to determine the nature of the query. (P.I.-1.3.1)* *LO2.2. Apply theory and principles of processing a query and its optimization to improve real-world database performance. (P.I.-1.4.1, PI-11.2.1 and PI 11.2.2)* *LO2.3. Evaluate the query statement. (P.I.-2.1.1)* *LO2.4. Compare and contrast the performance of various join algorithms to determine the best. (P.I.-2.2.4)*	
03.	**Parallel databases** ***Learning Objective/s:*** *Expected to analyse and apply parallel database architectures and I/O parallelism techniques to design and optimize efficient database systems.*	**5-7**
	Contents: Introduction ,Parallel database architecture, I/O parallelism, Inter-query and Intra-query parallelism, Interoperation and Intra-operational parallelism, Factor to consider in parallel systems design.	
	Self-Learning Topics: *Parallel indexing.*	
	Learning Outcomes:	
	Learner should be able to *LO3.1. Apply Engineering knowledge to understand parallelism in database systems. (P.I.-1.3.1)* *LO3.2. Apply theory and principles of parallel databases. (P.I.-1.4.1)* *LO3.3. Identify processes of parallel database system to solve real world problem by analyzing any sourced technical information. (P.I.-2.1.2, PI-11.2.2 and*	

	P.I.11.3.2) *LO3.4. Compare and contrast I/O parallelism with respect to query and operations. (P.I.-2.2.4)*	
04.	**Distributed Databases** ***Learning Objective/s:*** *Expected to analyse and apply distributed DBMS architectures, transaction management, and concurrency control techniques, including fragmentation, replication, and locking-based methods.*	**9-11**
	Contents: Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design. Distributed Transaction Management – Definition, properties, types, architecture, Distributed Concurrency Control- Taxonomy, Locking based, Basic TO algorithm	
	Self-Learning Topics: *Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing,* *Recovery in Distributed Databases: Failures in distributed database, 2PC and 3PC protocol.*	
	Learning Outcomes: *A learner will be able to* *LO4.1. Apply Engineering knowledge to understand distributed database systems architecture and techniques for fragmentation and replication for distributed database design. (P.I.-1.3.1)* *LO4.2. Apply theory and principles of distributed databases to understand transaction management and concurrency control. (P.I.-1.4.1)* *LO4.3. Identify suitable concurrency control algorithm that applies to the real-world problem enabling lifelong learning. (P.I.-2.1.3,PI-11.2.1 and 11.2.2)* *LO4.4. Compare and contrast distributed concurrency control techniques. (P.I.-2.2.4)* *LO4.5 To demonstrate design alternative by applying data fragmentation technique on the given database and present the work using appropriate tools. (PI-3.2.1, P.I- 5.1.1, PI-5.2.2, PI-8.2.1, PI-8.3.1, PI-9.1.1 and PI-9.3.1)* *LO4.6 Produce Varity of design solutions which suits the problem statement. (PI-3.2.2)*	
05.	**Data interoperability – XML and JSON** ***Learning Objective/s:*** *Expected to demonstrate XML and JSON technologies for data representation, querying, transformation, and communication, comparing their efficiency and usage*	**7-9**
	Contents: XML Databases: Document Type Definition, XML Schema, Querying and Transformation: XPath and XQuery, Basic JSON syntax, (Java Script Object Notation), JSON data types, Stringifying and parsing the JSON for sending & receiving, JSON Object retrieval using key-value pair and jQuery, XML Vs JSON	

	Self-Learning Topics: *MongoDB Shell* ***Learning Outcomes:*** *A learner will be able to* *LO5.1. Apply and demonstrate Engineering knowledge to understand XML and JSON data representation and querying using appropriate tool and present the work in team. (P.I.-1.3.1, P.I- 5.1.1, PI-5.2.2, PI-8.2.1, PI-8.3.1, PI-9.1.1 and PI-9.3.1)* *LO5.2. Apply theory and principles of XML and JSON in creation and representation and querying of data. (P.I.-1.4.1)* *LO5.3. Evaluate problem statements and give appropriate XML and JSON for any real-world application. (PI-2.1.1, PI-11.2.1, PI- 11.2.2)* *LO5.4 Compare and contrast XML and JSON methods to select the best methods for the given scenario. (PI-2.2.4)*	
06.	**NoSQL Distribution Model** ***Learning Objective/s:*** *Apply and demonstrate NoSQL concepts, including data modelling, replication, sharding, and consistency, and compare key-value, document, and column-family stores with the CAP theorem and ACID properties.*	**9-11**
	Contents: NoSQL database concepts: NoSQL data modelling, Benefits of NoSQL, comparison between SQL and NoSQL database system., Replication and sharding, Distribution Models Consistency in distributed data, CAP theorem, Notion of ACID Vs BASE, handling Transactions, consistency and eventual consistency, 6.3 Types of NoSQL databases: Key-value data store, Document database, Column Family Data store and Graph store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
	Self-Learning Topics: *Graph NoSQL data store Neo4j.*	
	Learning Outcomes: *A learner will be able to* *LO6.1. Apply Engineering knowledge to understand NoSQL database Concepts. (P.I.-1.3.1)* *LO6.2. Apply and demonstrate theory and principles of NoSQL in representing data in various types of NoSQL using appropriate tool and present the work. (P.I.-1.4.1, PI-5.1.1 ,PI-5.2.2, PI-8.2.1,PI-8.3.1,PI-9.1.1 and PI-9.3.1).* *LO6.3. Compare and contrast various NoSQL datastores to choose the best for the given real-world scenario by analyzing sourced technical information. (PI-2.2.5, PI-11.2.2 and PI-11.3.2).* *LO6.4 Identify the constraints of each of the NoSQL data store to understands its suitability in respective applications. (PI-2.3.2)*	
	Course Conclusion Mastering advanced database management systems equips students with the skills to manage complex data securely and efficiently, opening career opportunities in database administration, data engineering, and business intelligence, while providing a strong foundation for research in data optimization and emerging technologies.	01
Total		**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem.
2.2.4	Compare and contrast alternative solution/methods to select the best methods
3.2.1	Able to explore design alternatives
3.2.2	Able to produce Varity of potential design solutions suited to meet functional requirements.
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contribution from all individual efforts.
9.1.2	Produce clear, well-constructed and well supported written engineering document.
9.3.2	Use a verity of media effectively to convey a message in a document or presentation.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
11.3.2	Analyse sourced technical and popular information for feasibility, viability, sustainability etc.

Course Outcomes:

Learner will be able to

1. Apply and analyse database concepts to effectively address challenges related to data storage, retrieval, consistency, scalability, transaction management, query optimization, and handling large datasets in real-world applications. *(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Analyse and optimize query to enhance execution efficiency, minimize memory usage, and improve scalability. *(LO2.1, LO2.2, LO2.3, LO2.4)*
3. Analyse and apply parallel architectures and I/O techniques for enhanced database performance. (*LO3.1, LO3.2, LO3.3, LO3.4)*
4. Design distributed database architectures, transaction management, concurrency control, and effectively demonstrate and present data fragmentation with replication techniques in a team-oriented approach. *(LO4.1, LO4.2, LO4.3, LO4.4, LO4.5, LO4.6)*
5. Apply and demonstrate XML and JSON technologies for efficient data representation, querying, and communication effectively through a collaborative teamwork.*(LO5.1, LO5.2, LO5.3, LO5.4)*
6. Apply and demonstrate NoSQL concepts for data modelling, distribution, and consistency and present outcome effectively through a contributory teamwork.
   (LO6.1, LO6.2, LO6.3, LO6.4)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC5012.1	3	3									3
CEPEC5012.2	3	3									3
CEPEC5012.3	3	3									3
CEPEC5012.4	3	3	3		3			3	3		3
CEPEC5012.5	3	3			3			3	3		3
CEPEC5012.6	3	3			3			3	3		3
Average	3	3	3		3			3	3		3

Text Books:

1. Database System Concepts, Korth, Slberchatz, Sudarshan, 6th Edition, McGraw Hill
2. Fundamentals of Database Systems, Elmasri and Navathe, 5th Edition, Pearson Education
3. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH

Reference Books:

1. Database Systems Design, Implementation and Management, Peter Rob and Carlos Coronel, 5th Edition, Thomson Learning
2. SQL and PL/SQL for Oracle 10g, Black Book, Dr. P.S. Deshpande, Dreamtech Press.
3. Database Management Systems, G. K. Gupta, 2012, McGraw Hill

Other Resources:

1. https://archive.nptel.ac.in/courses/106/104/106104135/
2. https://www.scaler.com/topics/dbms/distributed-database-in-dbms/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

Two Class test: 05 Marks.

One Open Book Class test/Group Activity: 05 Marks.

Regularity and active participation: 05 Marks.

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC5013	COMPUTER GRAPHICS AND ANIMATION	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. BSC101- Engineering Mathematics -I
2. BSC204- Engineering Mathematics -II
3. CEPCC301- Engineering Mathematics -III

Program Outcomes addressed:

1. PO1- Engineering knowledge
2. PO2- Problem analysis
3. PO5: Engineering Tool Usage
4. PO8: Individual and Collaborative Team work
5. PO9: Communication

Course Objectives:

1. To introduce the fundamental concepts and applications of computer graphics and its significance in various fields.
2. To develop an understanding of the algorithms and techniques for rendering, transformations, and visualizations in 2D and 3D.
3. To equip students with knowledge of advanced concepts like rendering, shading, and animation workflows for realistic and interactive graphics.
4. To foster problem-solving and programming skills using graphical libraries for real-world applications.
5. To encourage self-learning and exploration of emerging trends in computer graphics and animation technologies.

Module	Details	Hrs.
	Course Introduction Computer graphics and animation are essential because they allow for visual representation, design, and simulation in a variety of domains, including data visualization, virtual reality, and gaming. They foster creativity, promote cutting-edge technology like artificial intelligence and robotics, and create job possibilities in technical design, software development, and multimedia. These abilities are essential in engineering since they enhance problem-solving and communication.	**01**

01.	**Basic of Computer Graphics** ***Learning Objective:*** *To familiarize learners with the fundamental concepts and applications of computer graphics.*	**3-5**
	Contents: Introduction, Uses of Computer graphics, Application of computer graphics, Graphics display devices: Raster scan and random scan Graphics Hardware and Software: GPU & Graphic Cards, Graphic Libraries (OpenGL, DirectX), Input & Output devices Graphic Pipeline: Stages of the Graphics Pipeline, Fixed and Programmable Pipelines.	
	Self-Learning Topics: *CRT, Overview of coordinate system, Scan conversion, rasterization, and rendering*	
	Learning Outcomes: *A learner will be able to* ***LO 1.1****: Apply the basic concepts and scope of computer graphics to identify its suitability in given scenario. (P.I.- 1.3.1)* ***LO 1.2:*** *Identify the components of the graphics pipeline and their functionalities in solving engineering problems. (P.I.- 1.4.1)* ***LO 1.****3: Identify the importance of computer graphics in real-world applications. (P.I.- 2.3.1)* ***LO 1.****4: Identify the appropriate type of graphic pipeline in given scenario(P.I.- 2.2.4)*	
02.	***Graphics Primitives and Drawing Algorithms*** ***Learning Objective:*** *To explore algorithms for rendering shapes using graphics primitives.*	**9-11**
	Contents: Points, Lines, and Polygons: Representation of Points and Lines, Polygon Types and Properties Line Drawing Algorithms: Digital Differential Analyzer (DDA) Algorithm, Bresenham's Line Drawing Algorithm Circle and Ellipse Drawing Algorithms: Midpoint Circle Algorithm, Midpoint Ellipse Algorithm Polygon Filling Algorithms: Scan-Line Algorithm, Flood Fill and Boundary Fill Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing	
	Self-Learning Topics: *Mathematical derivation of ellipse & circle*	
	Learning Outcomes: *A learner will be able to* ***LO 2.1:*** *Identify the appropriate type of polygons in given problem (P.I.- 2.2.4)* ***LO 2.2****: Apply engineering fundamentals to use various algorithms to show output in tabular form and draw basic geometric shapes. (P.I.- 1.3.1)* ***LO 2.3****: Apply polygon filling techniques to solve the given problem. (P.I.- 2.1.2)* ***LO 2.4****: Apply antialiasing in the given scenario. (P.I.- 1.4.1)*	

03.	**2D & 3D Transformations** ***Learning Objective:*** *To explore mathematical principles and techniques for object transformations.*	**9-11**
	Content Two dimensional geometric transformations – Translation, Scaling, Rotation, Reflection and Shear, Composite Transformation. Homogeneous Coordinates – Need of Homogeneous Coordinates, Transformation Matrices. Three-dimensional geometric transformation – translation, scaling, rotation, reflection and shear Projection – Parallel Projection (Orthographic, oblique), Perspective Projection (one-Point, Two-Point, Three-Point)	
	Self-Learning Topics: *closure properties of context free language*	
	Learning Outcomes: *A learner will be able to* ***LO 3.1****: Develop and apply transformation techniques to manipulate 2D and 3D objects using appropriate tools, while effectively collaborating and communicating results to class. (P.I.- 5.1.2, 5.2.2, 8.2.1, 8.3.1, 9.2.2, 9.3.2)* ***LO 3.2:*** *Identify the appropriate type of projection in given problem (P.I.- 2.2.4)* ***LO 3.3:*** *Solve problems related to object transformations and visualization (P.I.- 1.4.1)* ***LO 3.****4: Apply transformation techniques to manipulate objects in 2D and 3D spaces. (P.I.- 2.4.1)*	
04.	**Viewing and Clipping** ***Learning Objectives:*** *To familiarize learners with viewing transformations and techniques to manage visibility.*	**6-8**
	Contents: Viewing Pipeline: Viewing Coordinate System, Steps in the Viewing Process Window to Viewport Transformation: Mapping Algorithms, Aspect Ratio Preservation Line Clipping Algorithms: Cohen-Sutherland Line Clipping Algorithm, Liang-Barsky Line Clipping Algorithm Polygon Clipping: Sutherland-Hodgman Algorithm, Weiler-Atherton Algorithm.	
	Self-Learning Topics: *Midpoint subdivision line clipping algorithm, Cyrus-Beck polygon clipping algorithm*	

	Learning Outcomes: *A learner will be able to* ***LO 4.1:*** *Apply the concept of the viewing pipeline and its stages on given scenario. (P.I.- 1.3.1)* ***LO 4.2:*** *Use clipping algorithms to manage the visibility of objects. (P.I.- 2.4.1)* ***LO 4.3:*** *Perform window-to-viewport transformations effectively on a given problem (P.I.- 1.1.1)* ***LO 4.4****: Compare different line clipping algorithm. (P.I.- 2.2.4)* ***LO 4.5:*** *Compare different polygon clipping algorithm. (P.I.- 2.2.4)*	
05.	**Rendering and Shading** ***Learning Objective/s:*** *Explore rendering and shading techniques for realistic visual effects.*	**5-7**
	Contents: Introduction to Rendering- Basic Rendering Pipeline, Role of Rendering in Graphics Illumination Models- Ambient Light, Diffuse Reflection, Specular Reflection, Phong Reflection Model Shading Models- Flat Shading, Gouraud Shading, Phong Shading Texture Mapping and Bump Mapping - Texture Coordinates and Mapping, Procedural Textures, Normal and Bump Mapping Techniques.	
	Self-Learning Topics: *Study advanced techniques in procedural texture generation and their applications in graphics*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply the principles of rendering and shading for the given problem. (P.I.- 1.4.1)* *LO 5.2: Apply the knowledge of engineering fundamentals on various illumination models to enhance realistic rendering in computer graphics. . (P.I.- 1.3.1)* *LO 5.3: Apply shading models to create realistic graphical objects. (P.I.- 2.1.2)* *LO 5.4: Identify how texture and bump mapping can be used to enhance visual effects using appropriate tools (P.I.- 2.2.3, 5.1.1, 5.2.2)*	
06.	**Introduction to Animation** ***Learning Objective/s:*** *To explore the fundamental animation techniques and workflows.*	**5-7**
	Contents:	
	Basics of Animation- Principles of Animation, Frame Rate and Persistence of Vision Keyframing and Tweening- Keyframe Animation Workflow, Interpolation Techniques Animation Techniques- Traditional Animation, Computer Animation, Procedural Animation, Physics-Based Animation Introduction to Motion Capture- Motion Capture Systems, Applications of Motion Capture.	

	Self-Learning Topics: ***Visible Surface Detection algorithms***	
	Learning Outcomes : *A learner will be able to* *LO 6.1: Apply the basic concepts of animation and its principles on given scenario (P.I.- 1.3.1)* *LO 6.2: Apply keyframing and tweening techniques to solve the given problem. (P.I.- 1.4.1)* *LO 6.3: Differentiate between traditional and modern animation methods. (P.I.-2.2.4)* *LO 6.4: Identify the appropriate type of motion capturing in given problem (P.I.- 2.4.1)* *LO 6.5: Apply various animation techniques on given problem to transform techniques objects in 2D and 3D environment using suitable tools, collaborate effectively, and present results clearly to class. (P.I.- 5.1.2,5.2.2, 8.2.1, 8.3.1, 9.2.2, 9.3.2)*	
	Course Conclusion This course provides students with comprehensive knowledge of computer graphics and animation, equipping them with the skills needed to implement graphical and animation techniques in real- world applications and fostering a deeper understanding of the underlying principles and technologies.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
2.4.1	Apply engineering mathematics to solve the given problem
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation

Course Outcomes: A learner will be able to –

1. Apply & analyse the basic concepts of Computer graphics to the given problem.(*LO 1.1, LO 1.2, LO 1.3, LO 1.4*)
2. Identify & apply various algorithms for generating basic graphical objects.(*LO 2.1, LO 2.2, LO 2.3, LO 2.4*)
3. Develop skills to manipulate and visualize objects in 2D and 3D environments using appropriate tools, while effectively collaborating and communicating results to diverse audiences (*LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 6.5*)
4. Apply & compare various clipping algorithms on graphical objects. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5*)
5. Identify & analyse rendering techniques to achieve realistic visual effects. (*LO 5.1, LO 5.2, LO 5.3, LO 5.4*)
6. Apply & analyse various animation techniques to find solution of given problem. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC5013.1	3	3	-	-	-	-	-	-	-	-	-
CEPEC5013.2	3	3	-	-	-	-	-	-	-	-	-
CEPEC5013.3	2	3	-	-	3	-	-	3	3	-	-
CEPEC5013.4	3	3	-	-	-	-	-	-	-	-	-
CEPEC5013.5	3	3	-	-	3	-	-	-	-	-	-
CEPEC5013.6	3	3	-	-	3	-	-	-	-	-	-
Average	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**3**	**3**	**-**	**-**

Text Books :

1. J. D. Foley, A. Van Dam, S. K. Feiner, J. F. Hughes, "Computer Graphics: Principles and practice", Second Edition in C, Addison Wesley, 1997.
2. Donald Hearn, Pauline Baker M, "Computer Graphics", Prentice Hall, New Delhi, 2007.
3. Andleigh, P. K, Kiran Thakrar, "Multimedia Systems and Design", PHI, 2003
4. Hearn &Baker,"Computer Graphics C version", 2nd Edition, Pearson Publication

Reference Books :

1. D. F. Rogers, J. A. Adams, “Mathematical Elements for Computer Graphics”, Second Edition, McGraw Hill International Edition, 1990
2. F. S. Hill Jr., “Computer Graphics using OpenGL”, Second Edition, Pearson Education, 2003
3. Judith Jeffcoate, “Multimedia in Practice: Technology and Applications”, PHI, 1998
4. Zhigang Xiang, Roy Plastock, “Computer Graphics”, Schaum‟s Outlines McGraw-Hill Education
5. Rajesh K. Maurya,“Computer Graphics”,Wiley India Publication

Other Resources :

1. https://www.classcentral.com/course/interactivegraphics-2067
2. https://nptel.ac.in/courses/106106090https://nptel.ac.in/courses/106106090
3. https://onlinecourses.swayam2.ac.in/ntr20_ed15/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

Two Class test: 05 marks each

Group discussion/public speaking/technical report writing: 05 Marks

Regularity and Active participation : 05Marks

1. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC5014	DISTRIBUTED COMPUTING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite: *NIL*

Program Outcomes addressed:

1. PO1- Engineering knowledge
2. PO2- Problem analysis
3. PO4- Design/development of solutions
4. PO8- Individual and Collaborative Team work
5. PO9- Communication
6. PO11- Life Long Learning

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 guide in case of issues involved in replication and consistency and how fault tolerance can be achieved
6. To equip students with skills to analyse and design distributed applications.

Module	Details	Hrs
	Course Introduction A distributed computing course introduces the concept of distributed systems, which are computer systems that use multiple computers to solve a single problem. The course may cover topics such as fault tolerance, how to divide tasks into smaller subtasks, and how to coordinate activities between computers	**01**
01.	**Introduction to Distributed Computing**	**4-6**
	Learning Objective: *To introduce students with contemporary knowledge in distributed systems.*	

	Contents: Characterization of Distributed Systems: Issues, Goals, Types of distributed systems: Grid and Cluster Computing Models, Hardware and Software Concepts: NOS, DOS. Middleware: Models of middleware, Services offered by middleware.	
	Self-Learning Topics: *Middleware platforms such as CORBA, COM+*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply the concept of distributed system to identify the appropriate hardware and software required for distributed computing. (P.I.- 1.3.1)* *LO1.2: Apply computer network concepts to identify issues in distributed systems, evaluate techniques to address these challenges, and integrate new information to bridge knowledge gaps. (P.I.- 1.4.1, P.I 11.1.2)* *LO1.3: Recognize the need of distributed computing in the real-world applications (P.I.- 11.2.2)*	
02.	**Communication** ***Learning Objective:*** *To explore the various methods used for communication in distributed systems.*	**4-6**
	Contents: Interprocess communication: Remote Procedure Call (RPC), Remote Method Invocation (RMI). Message-Oriented Communication, Stream Oriented Communication, Group Communication.	
	Self-Learning Topics:NA	
	Learning Outcomes: *A learner will be able to* *LO2.1: Apply the concept of distributed computing to differentiate RPC, RMI and MOM (P.I.- 1.4.1)* *LO2.2: Differentiate between message oriented and stream oriented communication (P.I.- 1.3.1)* *LO2.3: Source and comprehend the technical literature related group communication in distributed computing. (P.I.- 11.3.1)*	
03.	**Synchronization** ***Learning Objective:*** *Expected to provide skills to measure the performance of distributed synchronization algorithms.*	**9-11**
	Contents: Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms 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.	

	Deadlock: Introduction, Deadlock Detection: Centralized approach, Chandy_Misra_Hass Algorithm.	
	Self-Learning Topics: NA	
	Learning Outcomes: *A learner will be able to* *LO3.1: Analyze physical and logical clock synchronization methods, identify existing solutions, and formulate justified approximations and assumptions to address timing issues in distributed systems. (P.I.- 2.2.3)* *LO3.2: Apply election algorithms to elect the new coordinator in distributed systems. (P.I.- 2.2.4)* *LO3.3: Create simulations or small-scale applications to evaluate token-based and non-token-based distributed mutual exclusion algorithms and present the findings in a group discussion. (P.I.- 2.1.2, 8.2.1, 8.4.1, 9.1.1, 9.2.2)* *LO3.4: Use the concept of 'happened before' relations for logical clock implementation in distributed systems. (P.I.- 1.3.1)* *LO3.5: Apply Chandy-Misra-Haas algorithm to detect deadlock situation. (P.I.- 1.4.1)*	
04.	**Resource and Process Management**	**6-8**
	Learning Objective: ***Expected to provide knowledge of resource management, and process management including process migration.***	
	Contents: Desirable Features of Global Scheduling algorithm, Task assignment approach, Load balancing approach and load sharing approach. Introduction to Process Management, Process Migration, Code Migration..	
	Self-Learning Topics: NA	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply task assignment approach to solve the given problem to improve the efficiency of the system. (P.I.- 1.3.1)* *LO4.2: Identify the desirable features of global scheduling algorithms (P.I.- 1.4.1)* *LO4.3: Compare the techniques used in address space transfer mechanism. (P.I.- 2.2.5)* *LO4.4: Analyze and apply existing solutions and methods for process management, forming justified approximations and assumptions to optimize scheduling, synchronization, and resource allocation in computing systems (P.I-2.2.3).* *LO4.5: Develop a small-scale application to compare load balancing and load sharing techniques, ensuring efficient task distribution across resources in distributed systems, and present the findings in a group discussion.(P.I.- 2.2.4, 8.2.1, 8.4.1, 9.1.1, 9.2.2)*	
05.	**Consistency, Replication and Fault Tolerance**	**7-9**
	Learning Objective/s: *Expected to learn issues involved in replication and consistency and how fault tolerance can be achieved.*	

	Contents: Distributed Shared Memory (DSM): Architecture, design issues. Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management. Fault Tolerance: Introduction, Process resilience, Recovery. ***Learning Outcomes:*** *A learner will be able to* *LO5.1: Identify the appropriate consistency model for the given scenario and vice versa. (P.I.- 4.1.2)* *LO5.2: Identify the design issues involved in DSM. (P.I.- 1.3.1)* *LO5.3: Gain knowledge of replication techniques and the importance of consistency in distributed systems. (P.I.- 1.4.1)* *LO5.4: Differentiate between data-centric and client-centric consistency models to find their impact on system design and performance in distributed systems. (P.I.- 2.2.4)* *LO5.5: Identify and evaluate existing solutions and methods for replica management, forming justified approximations to enhance the performance in distributed systems.(P.I- 2.2.3)* *LO5.6: Use the appropriate techniques to find the faulty processes in distributed systems.(P.I.- 4.3.1)*	
06.	**Distributed File Systems** ***Learning Objective:*** *Expected to be equipped with skills to analyse and design distributed applications.*	**5-7**
	Contents: Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Network File System (NFS). Designing Distributed Systems: Google Case Study. ***Self-Learning Topics: NA*** ***Learning Outcomes:*** *LO6.1: Summarize the features and functionalities of Distributed File Systems (DFS) and explain its importance with respect to the evolving technologies in distributed computing. (P.I.- 1.3.1, P.I- 11.1.1)* *LO6.2: Apply the theory and principles of computer science and engineering to optimize cache location for enhancing system performance and solving engineering problems related to data access and latency. (P.I- 1.4.1)* *LO6.3: Apply the concept of distributed file system to analyse the given case study (P.I.- 11.2.2)*	
	Course Conclusion After studying the course distributed computing the student should have a solid understanding of the fundamental concepts and techniques used in the design, implementation, and management of distributed systems.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.4.4	Arrive at conclusions with respect to the objectives.
4.1.2	Able to choose appropriate procedure/algorithm, dataset and test cases.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.4.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
11.3.1	Source and comprehend technical literature and other credible sources of information.

Course Outcomes: A learner will be able to -

1. Apply distributed system technologies to identify the necessity of distributed computing and the mechanisms used for Inter-process communication in real-world application. *(LO1.1, LO1.2, LO1.3, LO2.1, LO2.2, LO2.3)*
2. Apply and analyse various techniques for clock synchronization, mutual exclusion, and deadlock.*(LO3.1, LO3.2, LO3.4)*
3. Effectively manage resources and processes in distributed computing systems, ensuring optimal resource allocation, load balancing, fault tolerance, and scalability to enhance system performance and reliability.*(LO4.1, LO4.2, LO4.3, LO4.4)*
4. Demonstrate the concepts of consistency, replication management, and fault tolerance by analyzing their principles, implementing strategies to maintain data integrity and availability, and evaluating their impact on the reliability and performance of distributed systems. *(LO5.1, LO5.2, LO5.3, LO5.4, LO5.5)*
5. Apply the knowledge of Distributed File systems in building large-scale distributed applications and effectively communicate and present results as a team, and produce clear, well-structured result. *(LO3.3, LO4.5, LO6.1, LO6.2, LO6.3)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC5014.1	3	-	-	-	-	-	-	-	-	-	3
CEPEC5014.2	3	3	-	-	-	-	-	3	3	-	-
CEPEC5014.3	3	3	-	-	-	-	-	3	3	-	-
CEPEC5014.4	3	3	-	3	-	-	-		-	-	-
CEPEC5014.5	3	-	-	-	-	-	-	-	-	-	3
Average	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**-**	**3**

Text Books:

1 Andrew S. Tanenbaum and Maarten Van Steen, "*Distributed Systems: Principles and Paradigms"*, 2nd edition, Pearson Education.

2 Mukesh Singhal, Niranjan G. Shivaratri, "*Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems*", MC Graw Hill education.

3 Pradeep K.Sinha, *"Distributed Operating System-Concepts and design"*, PHI.

Reference Books:

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.

Other Resources:

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

Assignment on Live problems/case studies: 10 Marks.
Group Discussion/ Technical Report writing: 05 Marks.
Regularity and active participation: 05 Marks.

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	CELBC506	SOFTWARE ENGINEERING LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total**
25	25	50

Pre-requisite:

1. ESL205- Programming Laboratory-II (Java)
2. ESCL103 - Python Programming

Program Outcomes addressed:

1. PO2 : Problem Analysis
2. PO3 : Design/Development of Solutions
3. PO4 : Conduct investigations of complex problems
4. PO5: Engineering Tool Usage
5. PO7 : Ethics
6. PO8 : Individual and collaborative team work
7. PO9 : Communication
8. PO10 : Project management and finance
9. PO11 : Life-long learning

Course Objectives:

1. To divulge knowledge on Software Engineering and UML in an interactive manner through online methods.
2. To relate case studies to demonstrate the practical applications in areas of software engineering.
3. To provide an exposure to the students where they can solve small, real life problems.

Module	Detailed Contents	Hrs.
	Course Introduction Software Engineering Laboratory is the center of software development applications, driving detailed step by step approach for the creation of a given project. It focuses mainly on providing hands on environment to apply theoretical knowledge of software engineering concepts. This laboratory enables students with the practical skills and tools to build responsive and efficient real world software.	**01**

01.	**Software Process Models and Requirement gathering** ***Learning Objective:*** *To identify requirements and apply software process model to selected case study.*	**6**
	Contents: Introduction to basics of software engineering, analysis of a traditional and an agile model by identifying the requirements for a given problem statement, preparing a software requirement specification in a standard form.	
	Demonstration: 1. Application of a traditional process model. 2. Application of an agile process model. 3. Design a SRS document in IEEE format. 4. Construct a requirement model for the given case study. **Task1:** 1) Select a given case study (eg. Course Registration System) analyse and apply atleast one traditional process model. 2) Select a different case study (eg, Online Food Delivery System), analyse and apply atleast one agile model. **Task 2:** Identify the requirements (functional and non-functional) for any one of the above selected problem statement and design an SRS document in an IEEE format. **Task 3:** Using requirement modeling techniques construct Data flow diagram or class diagram for the same case study.	
	Self-Learning Topics: *Implement Scrum process model* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Analyze and apply the process model for a given case study. (P.I.-2.2.5), (P.I.- 3.1.1), (P.I.- 4.1.1), (P.I.-8.1.1) (P.I.- 9.1.1)* *LO 1.2: Design a software specification based on given requirement/data using appropriate requirements modeling technique. (P.I.- 2.1.2) (P.I.- 3.1.2), (P.I.- 3.1.4), (P.I.- 3.1.6), (P.I.- 4.3.3), (P.I.-8.3.1), (P.I.- 9.1.2)*	
02.	**Modelling and Designing** ***Learning Objective:*** ***To develop architectural models for the selected case study.***	**8**
	Contents: Designing the framework architecture of the given case study with the help of UML diagrams.	

	Demonstration: 1) Construct a use case diagram for the same case study using Dia 2) Construct an activity diagram for the same case study Dia **Task 4:** Set up the development environment, design and develop UML diagrams(use case, activity, state) with appropriate layouts, for the given problem statement by applying fundamental concepts of the development environment and UML components.	
	Self-Learning Topics: *Modelling of Component Diagrams* *Modelling of Swimlane Diagrams* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Explore and Assess the architectural considerations of a given application so as to meet its functional requirements and interaction with the external entities.* *(P.I.-2.1.1), (P.I.-3.2.2), (P.I.-4.1.1), (P.I.-5.1.1), (P.I.- 9.1.1), (P.I.-11.3.2)* *LO 2.2: Proficiently apply the appropriate tools for modeling the given problem statement.* *(P.I.-2.4.2), (P.I.-3.1.1), (P.I.-4.1.3), (P.I.-5.2.2), (P.I.-8.3.1), (P.I.- 9.3.1)*	
03.	**Planning and Software Configuration Management:** ***Learning Objective:*** ***To be able to perform scheduling and version controlling***	**08**
	Contents: To provide hands-on in project management tools and techniques, enabling students to effectively manage tasks, costs, progress, and versioning in real-world projects. **Demonstration:** 1) Estimate cost and effort required for the development of the given software project. 2) Construction of a timeline chart using Ganttpro, Trello 3) Assess the status of the ongoing software project 4) Manage version control using Github	

	Task 5: Applying mathematical models to predict the overall project expenses using empirical models like COCOMO model. **Task 6:** Creation of a timeline chart, such as a Gantt chart or using project management tools like Trello, to effectively schedule tasks within a project and manage task dependencies. **Task 7:** Application of earned value analysis (EVA) to monitor and track the progress of a project. **Task 8:** Lastly manage changes, track different versions, and collaborate efficiently in team-based projects by using GitHub's version control system. ***Self-Learning Topics:*** *Estimation of Test Coverage Metrics and Structural Complexity* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Demonstrate the ability to estimate the cost and effort using various software estimation techniques for a given problem statement. (P.I.-2.2.3), (P.I.-3.1.3), (P.I.-7.1.1), (P.I.-9.1.2), (P.I.-10.1.2), (P.I.-10.2.1), (P.I.-10.3.1)* *LO3.2: Create a timeline chart to schedule the required tasks that are planned for the completion of a software project and assess the status of the ongoing project. (P.I.-2.1.1), (P.I.-3.1.1), (P.I.-4.3.3), (P.I.-5.1.1), (P.I.-8.3.1), (P.I.-9.3.1), (P.I.-10.3.2)* *LO 3.3: To demonstrate the proficiency in performing version controlling using an appropriate tool. (P.I.-4.1.3), (P.I.-5.2.2), (P.I.-7.2.2)*	
04.	**Software Testing and Risk Monitoring** ***Learning Objective:*** ***To monitor risks and check the performance of the software by using testing strategies.***	**07**
	Contents: Introduction to basics of testing environment by including creation of test cases and effective risk management in software development. **Demonstration:** 1) Creation of test cases using white box testing 2) Creation of test cases using black box testing 3) Construction of an RMMM plan. **Task 9:** Developing test cases based on the internal logic of the given system to ensure all branches, paths, and conditions in the code are covered. (white box testing).	

	Task 10: Further testing the software without any knowledge of its internal workings so as to focus on the software's functionality from an end-user perspective by constructing test cases (black box testing). **Task 11:** Finally, Construction of a plan for managing and mitigating risks throughout the software development lifecycle. (RMMM plan) ***Self-Learning Topics:*** *Develop Test plan* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Select a suitable white box testing and black box testing technique to create test cases for a given case study. (P.I.-2.2.3), (P.I.-2.2.4), (P.I.-3.4.3), (P.I.-4.1.2), (P.I.-5.1.1), (P.I.-8.3.1), (P.I.-9.1.1), (P.I.-9.1.2), (P.I.-11.3.1).* *LO 4.2: Create an RMMM plan in identifying the risks with respect to its impact and probability to occur. (P.I.-2.1.1), (P.I.-3.1.1), (P.I.-4.3.1), (P.I.-4.3.2), (P.I.-5.2.2), (P.I.-7.2.2), (P.I.-9.3.1), (P.I.-11.3.2)*	
	Course Conclusion: Upon completion of the Software Engineering Lab, students will acquire the proficiency of teamwork and project management by working on real-world projects.	
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a Problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution/methods to select the best methods.
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.4.2	Analyze and interpret the results using contemporary tools.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.1.2	Able to identify and document system requirements from stake holders.
3.1.3	Able to review state-of-the-art literature to synthesize system requirements.
3.1.4	Able to choose appropriate quality attributes as defined by ISO/IEC/IEEE standard.
3.1.6	Able to develop software requirement specifications (SRS).
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
4.1.1	Define a problem for purposes of investigation, its scope and importance.
4.1.2	Ability to choose appropriate procedure/algorithm, data set and test cases.
4.1.3	Able to choose appropriate hardware/software tools to conduct the experiment.

4.3.1 Use appropriate procedures, tools and techniques to collect and analyze data.

4.3.2 Critically analyze data for trends and correlations, stating possible errors and limitations.

4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions.

5.1.1 Identify modern engineering tools, techniques and resources for engineering activities.

5.2.2 Demonstrate proficiency in using discipline-specific tools.

7.1.1 Identify situations of unethical professional conduct and propose ethical alternatives.

7.2.2 Examine and apply moral & ethical principles to known case studies.

8.1.1 Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.

8.3.1 Present results as a team, with smooth integration of contributions from all individual efforts.

9.1.1 Read, understand and interpret technical and non-technical information.

9.1.2 Produce clear, well-constructed, and well-supported written engineering documents.

9.3.1 Create engineering-standard figures, reports and drawings to complement writing and presentations.

10.1.2 Analyze different forms of financial statements to evaluate the financial status of an engineering project.

10.2.1 Analyze and select the most appropriate proposal based on economic and financial considerations.

10.3.1 Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.

10.3.2 Use project management tools to schedule an engineering project so it is completed on time and on budget.

11.3.1 Source and comprehend technical literature and other credible sources of information.

11.3.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to-

1. To identify requirements and apply process model to the selected case study. *(LO 1.1, LO 1.2)*
2. To analyze and design models for the selected case study using UML modeling *(LO 2.1, LO 2.2)*
3. To use various software engineering management tools. *(LO 3.1, LO 3.2, LO 3.3)*
4. To apply testing principles and RMMM for the selected case study *(LO 4.1, LO 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELBC506.1	-	3	3	3	-	-	-	3	3	-	-
CELBC506.2	-	3	3	3	3	-	-	2	3	-	2
CELBC506.3	-	3	3	3	3	-	3	2	3	3	-
CELBC506.4	-	3	3	3	3	-	2	2	3	-	3
Average	-	3	3	3	3	-	3	3	3	3	3

Text Books:

1. Software Engineering A Practitioner's Approach, Roger S. Pressman, 8th Edition, McGraw-Hill Publication.
2. The unified modeling language user guide, Grady Booch, James Rambaugh, Ivar Jacobson, 2nd edition, Pearson Education, 2005

3. **Reference Books:**

1. Fundamentals of Software Engineering, Rajib Mall, 5th edition, Prentice Hall India, 2014.

Other Resources:

1. Dia diagram Editor: http://dia-installer.de/
2. GitHub for Open Source Projects: https://github.com
3. Trello (opensource): https://trello.com/

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution Practical Exercises- 10 Marks Internal Assessment-
Practical Test – 10 Marks

Evaluation of the conceptual, problem solving and programming skills of each student will be assessed based on their approach towards problem solving, implementation of concepts and execution of the task using a software tool.

Regularity and active participation - 5 Marks.

END SEMESTER EXAMINATION (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/Algorithmic knowledge
- Practical programming knowledge
- Oral

- Students will be randomly allocated an experiment from the list of laboratory exercises and will be asked to write appropriate steps for the same. The steps are checked by the examiners (Internal and External) and weightage for this is 05 Marks.

Then the student will be allowed to start with the implementation of the experiment.

- Students will be allocated 1 hour to complete the execution. The experiment is then checked by both the examiners for its correctness. The weightage of the program implementation is 10 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LBC	CELBC507	APPLICATION DEVELOPMENT LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total**
25	25	50

Pre-requisite:

1. ESL205- Programming Laboratory-II (Java)

Program Outcomes addressed:

1. PO2 : Problem Analysis
2. PO3 : Design/Development of Solutions
3. PO5: Engineering Tool Usage
4. PO6 : The Engineer & The World
5. PO7 : Ethics
6. PO11: Life-long learning

Course Objectives:

1. To familiarize with the lifecycle of mobile applications.
2. To facilitate in developing a responsive mobile application for enhanced user experience across devices.
3. To provide hands-on experience in implementing database connectivity to create dynamic mobile applications with data-driven content.
4. To encourage in exploring emerging trends such AI and ML to build intelligent mobile applications.

Module	Detailed Contents	Hrs.
	Course Introduction This laboratory enables students to understand the entire ecosystem of mobile applications, from design and development to deployment. It equips students with the skills to build responsive, secure, and efficient mobile applications, which enable them to excel in a rapidly evolving technology landscape.	**01**
01.	**User Interface Design and Navigation** ***Learning Objective:*** *Expected to implement basic and advanced UI components for mobile apps.*	**4-6**
	Contents: Introduction to basics of development environment and UI components for mobile applications including set up, creating a basic application with proper layouts and UI/UX interface.	

	Laboratory Exercise (Suggested Tasks): Set up the development environment, design and develop a basic application with appropriate layouts, and ensure a user-friendly UI/UX interface for the given problem statement by applying fundamental concepts of the development environment and UI components.	
	Self-Learning Topics: *Implement touch events and gestures* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Demonstrate the ability to design and implement responsive layouts that adapt to different screen sizes and orientations using XML for the given problem statement. (P.I.- 2.1.1, 2.2.4, 3.2.1,3.2.2)* *LO 1.2: Explore the advanced UI components to build interactive user interfaces for the given problem statement. (P.I.- 2.1.2,3.2.2,5.1.2)* *LO 1.3: Enhance the mobile app by implementing various navigation patterns for the given problem statement. (P.I. – 2.2.4, 3.2.1, 3.2.2)*	
02.	**Back End Integration and Data Handling** ***Learning Objective:*** *To demonstrate proficiency in using RESTful API and SQLLite database to create a database, manipulate the database and update or delete data with user authentication.*	**7-9**
	Contents: Basics of back end (CRUD operations), integration of back end with Android applications including authorization and handling of data. **Laboratory Exercises (Suggested Tasks):** Develop an Android application based on the given problem statement by implementing backend functionality. Perform CRUD operations, integrate the backend with the application, and implement authorization and data handling to ensure secure and efficient communication between the frontend and backend.	
	Self-Learning Topics: *Store and retrieve data from Firebase Firestore.* *Implement Firebase Cloud Messaging (FCM) for push notifications* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Integrate RESTful APIs into mobile applications using appropriate libraries XML for the given problem statement. (P.I.- 2.1.1, 3.2.1, 5.2.2)* *LO 2.2: Execute CRUD operations on local databases and ensure data synchronization with remote servers XML for the given problem statement (P.I.- 2.2.2, 2.3.1, 3.4.2)* *LO 2.3: Proficiently use SQLite for local data storage for better data management XML for the given problem statement.(P.I.- 5.1.2,5.2.2)*	

03.	**Network Connections and Multimedia, Entertainment and GPS Based Services** ***Learning Objective:*** *Utilize the network connections to communicate with other devices for the exchange of data efficiently.* *To demonstrate proficiency in using multimedia and GPS-based services to build value added mobile app.*	**7-9**
	Contents: Introduction to network connections for data communication with other devices, integration of multimedia, GPS based services with mobile applications. **Laboratory Exercises (Suggested Tasks):** Develop a mobile application based on the given problem statement by implementing network connections for data communication with other devices. Integrate multimedia features and GPS-based services to enhance functionality and user experience.	
	Self-Learning Topics: *Monitor app performance using Firebase Analytics* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Select and implement the appropriate network connection for data exchange using Mobile for the given problem statement. (P.I.- 2.1.1, 2.2.4, 3.2.1, 3.4.2, 7.1.1)* *LO3.2: Recognize fundamental skills in multimedia and entertainment services interaction with mobile app for the given problem statement (P.I.-5.1.2, 5.2.2, 7.1.1)* *LO 3.3: Demonstrate proficiency in creating GPS-based services to add more value to mobile app for the given problem statement (P.I.-5.1.2, 5.2.2, 7.1.1)*	
04.	**Emerging Trends** ***Learning Objective:*** *Utilize emerging trends – Machine Learning and IoT to build intelligent and efficient mobile applications that enhance mobile usability and user experience.*	**7-9**
	Contents: Exploring emerging trends such as ML, IoT towards building a smart, efficient and dynamic mobile applications. **Laboratory Exercises (Suggested Tasks):** Develop a smart and dynamic mobile application based on the given problem statement by integrating emerging technologies such as Machine Learning (ML) and the Internet of Things (IoT). Utilize these technologies to enhance efficiency, automation, and intelligent decision-making within the application.	

	Self-Learning Topics: *Build an Android app that uses ML Kit to recognize and extract text from images.* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Demonstrate the ability to develop a diverse range of mobile apps employing machine learning techniques for the given problem statement (P.I.- 2.1.1, 2.2.4, 2.3.1, 3.2.1, 3.4.2, 5.2.2, 6.1.1, 6.2.1, 7.1.1, 11.2.1)* *LO 4.2: Explore the expertise in the field of IoT developing sophisticated mobile apps to control devices from remote location for the given problem statement. (P.I.-3.2.1, 5.1.1, 5.1.2, 6.1.1, 6.2.1, 7.1.1,11.1.1)*	
	Course Conclusion: Upon completion of the Application Development Lab, students will acquire the proficiency to develop dynamic, interactive, and intelligent mobile applications.	
	Total	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.2	Identify functionalities and computing resources.
2.2.4	Compare and contrast alternative solution/methods to select the best methods.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
3.2.1	Able to explore design alternatives.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirement.
3.4.2	Able to implement and integrate the modules.
5.1.2	Adapt the tools and techniques to solve engineering problems.
5.2.2	Demonstrate proficiency in using discipline-specific tools.
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
11.1.1	Describe the rationale for the requirement for continuing professional development
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current

Course Outcomes: A learner will be able to-

1. Design and develop responsive user interface for mobile applications. *(LO 1.1, LO 1.2, LO 1.3)*
2. Develop a mobile application which connects the user interface with the back-end to store, retrieve, and manage data using modern tools. *(LO 2.1, LO 2.2, LO 2.3)*
3. Analyze and develop interactive mobile applications incorporating network, multimedia, and GPS services using modern tools, while ensuring data privacy and ethical practices. *(LO 3.1, LO 3.2, LO 3.3)*
4. Develop competent mobile applications using modern tools, considering societal impact, ethics and the need for continuous learning. *(LO 4.1, LO 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELBC507.1	-	3	3	-	2	-	-	-	-	-	-
CELBC507.2	-	3	3	-	3	-	-	-	-	-	-
CELBC507.3	-	3	3	-	3	-	2	-	-	-	-
CELBC507.4	-	3	3	-	3	3	2	-	-	-	3
Average	-	3	3	-	3	3	2	-	-	-	3

Text Books:

1. Professional Android 4 Application Development, Reto Meier, Wrox Publications.
2. Android User Interface Design, Ian G. Clifton, Pearson Education.
3. Beginning Android Programming with Android Studio, Wei-Meng Lee, Wiley.

Reference Books:

1. Head First Android Development, Dawn Griffiths and David Griffiths, O'Reilly.
2. Android: A Programmer's Guide, Jerome DiMarzio, McGraw-Hill.
3. Android Application Development All-in-One For Dummies, Barry Burd, Wiley.

Other Resources:

1. Android Developers Official Documentation: https://developer.android.com
2. Udacity Free Courses on Android: https://www.udacity.com
3. GeeksforGeeks Android Programming: https://www.geeksforgeeks.org
4. GitHub for Open Source Projects: https://github.com
5. Stack Overflow for Developers: https://stackoverflow.com

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution Practical Exercises- 10 Marks Internal Assessment-
Practical Test – 10 Marks

Evaluation of the conceptual, problem solving and programming skills of each student will be assessed based on their approach towards problem solving, implementation of concepts and execution of the task using a software tool.

Regularity and active participation - 5 Marks.

END SEMESTER EXAMINATION (Practical/Oral Examination) (25 Marks)

Students will be assessed based on three parameters:

- Concept/Algorithmic knowledge
- Practical programming knowledge
- Oral

- Students will be randomly allocated a program from the list of laboratory exercises and will be asked to write appropriate algorithm for the same. The algorithm is checked by the examiners (Internal and External) and weightage for this is 05 Marks.

Then the student will be allowed to start with the implementation of the program.

- Students will be allocated 1 hour to complete the execution. The program is then checked by both the examiners for its correctness. The weightage of the program implementation is 10 Marks.
- Students will then be appearing for Oral in front of both Internal and External examiners. The weightage of Oral will be of 10 Marks.

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
AEC	AEC 502	PROFESSIONAL COMMUNICATION & ETHICS-2	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO7 : Ethics
2. PO8 : Individual and Teamwork
3. PO9 : Communication
4. PO11: Life-long learning

Course Objectives:

1. To inculcate in students, professional and ethical attitude, effective communication skills, team work and a multidisciplinary approach.
2. To provide students with an academic environment where they will be aware of the need for excellence, leadership and lifelong learning to build a successful academic & professional career.
3. To create awareness about professional ethics and codes of professional practices.
4. To prepare students for a successful academic and/or professional career that meets the global academic and/or corporate requirement by providing students to work on multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork, and other interpersonal skills.

Module	Details	Hrs.
	Course Introduction The curriculum of Professional Communication and Ethics-2 is designed to provide students with an academic environment that promotes a professional and ethical attitude as they participate in individual and team activities. The practical sessions will supplement the learner's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global industrial and corporate requirements. The curriculum will create an awareness of professional ethics and the standard code of conduct. It will further inculcate within the budding engineer the social commitment as responsible technical citizens. It will enhance the learner's team building capacities, interpersonal skills and leadership skills so as to become a well-rounded professional in their field of expertise.	**01**

01.	**EMPLOYABILITY SKILLS** ***Learning Objectives:*** *1. Customised writing skills and Content Development: To develop effective writing skills to craft a clear, concise, and compelling Statement of purpose, formal letters and resumes for a specific purpose.* *2. To instil productive and efficient skills to participate confidently and constructively in group discussions and interviews for employability* *3. To inculcate Ethical Communication & Empathetic Listening*	
	Contents: **1.1 Business Correspondence** o Letter Writing (Principles, Format, Structure, Content, Types) o Job Application Letter o Joining Letter o Resignation Letter o Resume Writing **1.2 Statement of Purpose/ Letter of Intent or Interest** o Purpose o Elements of SOP/LOI o Structure o Tips for writing effective and ethical SOP/LOI **1.3 Verbal Aptitude Tests** modeled on CAT,GRE,GMAT,IELTS **1.4 Group Discussions**: Purpose, parameters of evaluating, Types of GDs (Traditional, Case-based & Role Plays), GD Etiquettes, and Importance of inclusivity, respectful listening and expression of diverse ideas for a common goal. **1.5 Personal Interviews:** Preparation, Types of questions, Types of interviews and modes of interviews. Types: Structured, Stress, Behavioural, Problem Solving & Case-based, Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual **1.6 Significance of Ethical approach during Group Discussions and Interviews** o Respectful listening o Speaking Assertively o Inclusivity of diverse individuals o Mindfulness and openness to different ideas o Common Goal of Consensus	**03**
	Self-Learning Topics: ***Watch recordings of professional interviews from online resources.(ex: Civil Service interviews), IIM and UPSC GDs*** ***Activities:*** *1. Prepare an SOP for admission procedure in a reputed university.*	

	2. Participate in GDs on a given topic followed by Mock Interview. *3. Attempt Verbal Aptitude and Comprehension Tests.* *4. Write a Job Application/Resignation/Request/Enquiry letter in the learned format* *5. Write a Resume as a fresh graduate trainee for a specific post.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Write clear, concise and professional letters of various types that effectively convey information, build relationships and achieve professional objectives.(9.1.3, 9.2.3, 9.3.2, 11.1.1)* *LO 1.2: Rationally apply gained knowledge of group discussions and aptitude tests for continuous improvement and professional growth in academia and industry. (8.1.2, 8.2.1, 11.1.1.)* *LO 1.3: Exhibit the ethical code of conduct by treating all team mates with respect and dignity, by listening attentively to each member, and encouraging diversity of ideas during a GD. (7.3.1, 8.1.1, 8.2.2,8.2.3, 8.2.4, 9.2.3)* *LO 1.4: Demonstrate through group discussions and mock interviews, the ability to effectively identify unethical conduct and arrive at ethical decisions through strong leadership skills and respectfully lead a team or oneself to the desired goal. (7.1.1,8.1.2,8.2.1,8.2.3, 8.2.4, 8.3.1,9.2.2, 9.2.3)* *LO 1.5: Exhibit a calm demeanor by effectively preparing for competitive exams through mock tests which contain comprehending logical instructions, analysis, problem solving and verbal aptitude assessment (8.2.4, 9.1.1,11.1.1)*	
02.	**INTERPERSONAL SKILLS & ETHICS** ***Learning Objectives:*** 1. *Develop Problem Solving & Critical Thinking: To help budding engineers understand the importance of interpersonal skills and demonstrate creativity, resourcefulness, along with enhanced communication in personal and professional settings.* 2. *Self-Management & Ethical Awareness: To create awareness of Ethical and Social Responsibility towards individual and society by fostering self and team management leading to increased productivity and job readiness.*	**03**
	Contents: **2.1 Interpersonal Skills (implementation in all AE activities)** o Emotional intelligence o Effective Leadership o Team Building o Conflict Management o Negotiation & Ethical Conflict Resolution o Time management, o Assertiveness **2.2 Importance of Ethics in Interpersonal Relations** o Ethical and Inclusive Decision making. o Ethics in relation to Emotional Quotient	
	Self-Learning Topics: Follow industry leaders and experts on social media or read articles on topics related to corporate ethics and social responsibility.	

	Activity: 1. *Listen to podcasts that discuss ethics, communication and interpersonal skills, such as "The TED Radio Hour" or "How I Built This" and conduct a GD on its learnings.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the learned interpersonal skills in various A.E. activities such as Report presentations, drafting business plans and SOP in an accepting, respectful and inclusive manner. (7.3.1,8.1.1, 8.1.2, 8.2.1, 8.2.2, 9.2.1, 9.2.3)* *LO 2.2: Apply the awareness of ethics while participating in a well-organized, time bound and constructive GD on topics raising ethical and moral concerns. (7.2.2, 7.3.1,8.2.1, 8.3.1, 9.2.3)* *LO 2.3: Apply empathetic and effective speaking skills utilizing ethical values and principles to resolve any social problem while working in a diverse team for group activities. (7.2.2, 7.3.18.1.1, 8.2.1, 8.2.2, 8.2.3, 9.2.1, 9.2.2.)* .	
03.	**ADVANCED TECHNICAL WRITING:PROJECT/PROBLEM BASED LEARNING** ***Learning Objective:*** *1. Structure & Organisation: To enable the learner to craft a well-structured technical report, utilizing a logical flow with clear introduction, body and flow, ensuring clarity and coherence in their writing.* *2. Effective Communication: To enhance the ability to communicate complex information clearly and concisely, using relevant visual aids and making the information accessible to technical and non-technical audience.*	**03**
	Contents: **3.1 Technical/Academic Report** ○ **Classification of reports on the basis of**: Subject Matter, Time Interval, Function, Physical Factors. ○ **Parts of a long formal report**: Front Matter, Main Body and Back Matter. ○ **Language and style of Reports:** Grammar, Tone, Style, Vocabulary, Format of the report from title page to appendices. **3.2 Definition, purpose and types of Proposal** ○ Parts of a Proposal**:** Elements, Scope and Limitations, Conclusion ○ Technical Proposal/Synopsis **3.3 Technical Paper Formats (APA/IEEE)** **Parts of a Research paper**: ○ Title Page ○ Abstract, ○ Introduction ○ Problem Statement/Hypothesis ○ Research methods, ○ Data Search (Primary/Secondary) ○ Quantitative/ Qualitative Analysis ○ Discussion, ○ Delimitations, ○ future scope and ○ References.	

	○ Appendix ○ Acknowledgement **3.4 Significance of Presenting and Publishing a Research Paper** ○ Reading Secondary Data ○ Looking for research gaps ○ Understanding Need to fill research gap ○ Creating a Problem Statement ○ Writing a Synopsis ○ Writing an academic paper in the APA/IEEE format	
	Self-Learning Topics: ***Read academic research papers and look for gaps in the research area.*** ***Activity*:** *1. Prepare an Academic Research Paper on any technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *The learner will be able to* *LO3.1: Write, individually or as a team, a research paper, with logical & rational progression of ideas, effectively, in a time bound manner to everyone's understanding (8.3.1, 9.1.3, 9.2.3)* *LO3.2: Read, comprehend, and interpret previous research/ secondary source data and clearly state the purpose of research using the IEEE format. (9.1.1,9.1.3,11.3.1)* *LO3.3: Demonstrate the ability to use critical thinking to find gaps in research, interpret the technical and non-technical data and present it with clarity. (9.1.1, 9.1.3, 11.1.2, 11.3.1)* *LO3.4: Apply gained knowledge of technical writing for continuous improvement in academia and professional growth. (11.1.1)*	
04.	**TECHNICAL/BUSINESS PESENTATIONS** ***Learning Objectives:*** *1. The development of effective presentation structure and content for academic and technical presentation with the help of ICT* *2.Capacity building for delivering confident and persuasive presentation to both technical and non-technical audience individually or in a team.*	**02**
	Contents: **4.1 Effective Presentation Strategies:** ○ Purpose of a presentation, ○ Understanding the audience, location and the event, ○ Arranging the material, structuring the presentation, ○ Making effective slides and platform skills. **4.2 Group Presentations:** ○ Working with a mixed team (Diversity) ○ Sharing responsibility in a team (Delegation) ○ Creating the content together (Uniformity) ○ Transition phases and Coordination. (Teamwork) ○ Time Management (Individual and Team) **4.3 Individual Presentations:**	

	○ Introduction of Self and Topic ○ Understanding the audience, building rapport ○ Time Management ○ End with Q n A, Feedback	
	Self-Learning Topics: *Watch YouTube videos of presentations like TED TALKS on motivational topics* ***Activity*:** *1. Prepare an academic research paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper + Presentation & Group Dynamics]*	
	Learning Outcomes: *A learner will be able to* *LO4.1: Demonstrate efficacious and seamless presentation skills to all audiences as an individual and a team with impeccable leadership qualities through proper delegation, problem solving and management (8.1.2, 8.2.1,8.3.1, 9.1.3, 9.2.2, 9.3.2)* *LO4.2: Engage with a diverse team and a mixed audience, during presentations, keeping in mind their uniqueness and differences. (7.3.1.,8.1.1,8.1.2,8.3.1,9.2.2, 9.2.3)*	
05.	***CORPORATE ETHICS*** ***Learning Objective/s:*** 1. *Ethical Principles & Frameworks: To aid the learner to differentiate between various codes of conduct and ethics in the social and professional world.* 2. *Analyse & Resolve Ethical Dilemmas: To enforce the significance of ethical citizenry & generate awareness on the importance of IPR and its consequences*	**02**
	Contents: **5.1. Intellectual Property Rights : Significance, Duration, Laws** ○ Copyrights ○ Trademarks ○ Patents ○ Geographical Indication ○ Industrial Designs ○ Trade Secrets **5.2. Start- Up Skills:** ○ Financial Literacy ○ Risk Assessment ○ Data Analysis. **5.3. Gender Equity & Inclusivity at the Work Place** ○ Study on Cases related to Gender Equity in India & Global ○ Corporate Social Responsibility ○ Inclusivity at the work place ○ Corporate Code of Conduct	
	Self-Learning Topics: Read a biography on a Business Leader/Philanthropist, Collect information on some failed startups. Assess and analyse the reasons for their failure. ***Activity:***	

	1. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* *2. Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Utilise professional, moral and ethical principles to identify wrong conduct and suggest ethical solutions through IPR, Gender Equity and Corporate ethics (7.1.1, 7.2.2, 7.3.1)* *LO 5.2: Critically evaluate various socioeconomic, gender issues of discriminatory nature, while emulating equality and open mindedness in all teams, sectors and activities. (7.1.1, 7.2.2,7.3.1, 8.1.1, 8.1.2, 9.2.3)* *LO 5.3: Employ the awareness of IPR to avoid or solve unethical practices in professional life by following standard rules and practices and emerge as a productive team member and a progressive leader. (7.1.1,7.2.2, 8.2.1, 8.2.2, 11.1.1)* *LO 5.4: Assess a failed business plan, analyse reasons for failure and suggest viable solutions as a team keeping in consideration both the individual and team effort. (8.2.1, 8.3.1,9.1.3, 11.1.2)*	
	Activities for Ability Enhancement (Practical Sessions):	**30**
	Contents: 1. *Write a job application letter, a joining letter, a letter of apology, a request letter. Attach a Resume to the Job Application letter. Follow Standard formats and protocols for each document. (5M)* 2. *Prepare an Academic Research Paper on any one Technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper (5M) + Presentation & Group Dynamics (5M)]* 3. *Prepare an SOP for admission procedure in a reputed university. (5M)* 4. *Participate in GDs on given topic followed by Mock Interview ((10 M)* 5. *Attempt Verbal Aptitude and Comprehension Tests(5M)* 6. *Find and analyse a Case Study on the topic on Gender Equity & Inclusivity; Generate a solution based article in APA format and present before an audience (10M)* ***OR*** *Assess and analyse a failed start up. Find gaps leading to failure. Give viable solutions; Generate an article in APA format; present before an audience. (10M)* 7. *Active Participation & Regularity (5M)*	
	Activities will start in the inverted pyramid, viz., with group activities first so as to build confidence and ending with solo presentations in the form of research paper presentation or Gender Equity presentation. *Group Discussion, Interview Skills, Presentation skills will have at least three mock drills before the final assessment of the same.* *Rigorous development of the English language, social and professional etiquette will be the praxis*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Examine and apply moral & ethical principles to known case studies
7.3.1	Apply and exhibit universal human values and a diverse and inclusive mind-set, free of discrimination
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.2.2	Treat other team members respectfully
8.2.3	Listen to other members
8.2.4	Maintain composure in difficult situations
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.2.3	Apply efficient and effective communication, keeping in mind the diversity and uniqueness in the team.
9.3.2	Use a variety of media effectively to convey a message in a document or a presentation
11.1.1	State the rationale for the requirement for continuing professional development
11.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
11.3.1	Source and comprehend technical literature and other credible sources of information

Course Outcomes: A learner will be able to -

1. Communicate and present effectively and ethically with mixed media in both oral and written forms business reports and documents which will in turn provide a solid foundation for their future managerial roles. (*LOs 1.1, 1.2, 1.4, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 5.1)*
2. Exhibit the skill set required for successful employability while expressing ethical, assertive and inclusive leadership skills. (*LOs 2.1, 2.2, 2.3, 3.2, 4.2, 4.3, 5.2)*
3. Develop a critical thinking acumen to prepare for and give various competitive exams, emerge successful in group discussions and conduct healthy debates. (*LOs 1.3, 2.1, 2.2, 2.3, 3.1, 4.2)*
4. Develop creative and mindful thinking while demonstrating the knowledge of professional and personal etiquettes & ethics, such as diversity and inclusivity, in the global environment. (*LOs 1.2, 2.2, 2.4,1.3, 3.2, 4.3, 5.1, 5.2, 5.3, 5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
AEC502.1							3	3	3		3
AEC502.2							3	3	3		3
AEC502.3							2	3	3		3
AEC502.4							3	3	3		3
Average							**3**	**3**	**3**		**3**

Reference Books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin:*
2. *Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill. 2. Bovée, C. L., &Thill, J. V. (2021).
3. *Business communication today*. Upper Saddle River, NJ: Pearson.
4. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
5. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South Western Cengage Learning.
6. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
7. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
8. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
9. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Other Resources :

1. NPTEL Course: https://archive.nptel.ac.in/courses/109/104/109104030
   Dept. of Humanities and Social Sciences, IIT Kanpur, A Course on Communication Skills

CONTINUOUS INTERNAL ASSESSMENT (50 Marks)

1. Assignments on Resume Writing and Business Correspondence (5M)
2. Prepare an Academic Research Paper (3500-4000 words) on any one socio-technical problem of your choice with solutions for the same and present it using ICT. [Team of 6/ Research Paper/ IEEE (5 M) + Presentation & Group Dynamics. (5M)]
3. Prepare an SOP for admission procedure in a reputed university. (5M)
4. Participation in Final GD on concrete/abstract topic followed by Mock Interview. (10M)
5. Verbal Aptitude Tests (5M)

6. Analyse a Case Study on the topic of Gender Equity & Inclusivity and present (APA)
   OR Analyse a failed start up present your case to a mixed audience (APA) (10M)
7. Regularity and Active participation (5M)

Course Type	Course Code	Course Name	Credits
MNP	CEMNP503	Mini Project- 2A	02

Course Objectives

1.To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in

- Research/white paper/article/blog writing/publication, etc.
- Business plan for entrepreneurship product creation
- Patent filing/copyright.

8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- 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 etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.

- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- 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.
- 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.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- The Head of the Departments will assign a guide to each of the mini-projects and shall form a progress monitoring committee. The guide will carry out weekly monitoring of the project's progress. The committee shall carry out in-semester project evaluation based on presentations with a minimum of two evaluations per semester.
- Assessment will be based on individual contributions, understanding, and responses to questions asked.
- Continuous Assessment marks distribution in semester V (50 marks):
    - 05 marks for the Topic Approval Presentation in front of the progress monitoring committee
    - 15 marks for the Mid-Semester Progress Presentation in front of the progress monitoring committee
    - 25 marks for the Final Report & Presentation
    - 05 marks for Regularity and Active Participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester V:

- Theoretical solution completion, including component/system selection/design of software solution and cost analysis.
- Two reviews will occur:
    - The first review will focus on finalizing the problem statement (topic approval).
    - The second review will centre on finalizing the proposed solution.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

Course Type	Course Code	Course Name	Credits
HSS	HSS502	ENTREPRENEURSHIP	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Pre-requisite: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/ Development of Solutions
4. PO6: The Engineer & The World.
5. PO7: Ethics
6. PO10: Project Management & Finance
7. PO11: Life-long learning

Course Objectives:

1. To develop Entrepreneurial mindset amongst the learners.
2. To promote Entrepreneurship as life-skills to improve quality of life, skills of creation and management of entrepreneurial pursuits.
3. To explore paths of the innovation through the creative problem-solving skills
4. To familiarize with the steps involved in 'idea to product' development.
5. To get acquainted with the preparation of pitch at ideation, business idea presentation and funding stages

Module	Details	Hrs
00	**Course Introduction:** This course aims to equip individuals with the knowledge, skills, and mindset needed to identify and pursue new business opportunities. It aims to foster an entrepreneurial culture and mindset to help develop the next generation of entrepreneurs who can create jobs, drive economic growth, and contribute to the society. Entrepreneurship is a life skill that will help an individual succeed in a variety of scenarios, both personal and professional. By its very nature, entrepreneurship is an interdisciplinary field that draws from a range of disciplines, including business, economics, engineering, and social sciences. Some of the key topics covered in Entrepreneurship Course include opportunity recognition, market research, business planning, financing, marketing, and management while emphasizing the development of critical thinking, creativity, risk-taking, and problem- solving skills.	**1**

1	**Fundamentals of Entrepreneurship**	5-6
	Learning Objectives: • *To gain knowledge about the concepts and principles of entrepreneurship, including opportunity recognition and value creation.* • *To develop an entrepreneurial mindset and skills that will enable them to identify, evaluate, and pursue viable business opportunities with confidence.*	
	Contents: Introduction to Entrepreneurship, Entrepreneurial Mindset, Opportunity Identification, Market Analysis & Customer Research, Business Models & Go-to-Market, Funding and Financial Management, Marketing Aspects, Scaling the Venture and Growth Strategies: *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Understand the concept of Entrepreneurship* • *State the myths, advantages and limitations of Entrepreneurship* • *Interpret and analyze market research data and customer analysis to make informed business decisions.* • *Discuss the steps in the process of Entrepreneurship*	
2	**Technological Innovation and Entrepreneurship**	4-5
	Learning Objectives: • *To enhance creative problem-solving skills and to examine the importance of innovation in business success.* • *To identify the types of Innovation* • *To gain knowledge for taking an idea to product development stage while protecting the idea with IPR.*	
	Content: Foundations of Creativity and Innovations, Creative thinking process, Types of Innovation: Incremental, Disruptive, and Radical, Innovation Process: from idea to execution; Protecting ideas - Patents and IPR. Exploring Technological Innovation through Case Studies.	
	Learning Outcome: *The learner would be able to* • *Use their understanding of the role Technological innovation plays in driving business success.* • *To formulate steps for taking an idea to product stage with necessary patents*	
3	**Ideation, Prototyping, Testing, Validation and Commercialisation**	5-6
	Learning Objectives: • *Experiment to test Minimum Viable Products (MVPs) and validate business ideas.* • *To formulate a Build-Measure-Learn feedback loop for continuous improvement.*	

	Contents: Identifying customer needs and problems to solve, Ideation, Concept Development, Design Thinking, Prototyping, Minimum Viable Product (MVP), Testing, and Iterations. Understanding the Market, customer feedback and refinement of business idea based on feedback. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Select specific measures to design, test, and validate Minimum Viable Products (MVPs) to assess business ideas.* • *Interpret the learnings from the build-measure-learn feedback loop to facilitate continuous improvement and learning.*	
4	**Financial Resources**	3-4
	Learning Objectives: • *Describe the key concepts, and strategies related to fundraising for entrepreneurial ventures.* • *Compare various funding sources, including angel investors, venture capitalists, grants, and crowdfunding platforms.* • *Devise and create compelling investor pitches, develop financial projections.*	
	Contents: Funding new ventures – bootstrapping, crowd sourcing, Angel investors, VCs, debt financing, and due diligence; Raising fund during life-cycle of a new ventures. *Note:* A real life case study covering key elements of the module shall be covered.	
	Learning Outcome: *The learner would be able to* • *Recognize various fundraising strategies and techniques, enabling s to choose the most appropriate funding sources for their entrepreneurial ventures.* • *Sketch effective pitches and fundraising campaigns tailored to different types of investors and funding sources, ensuring successful capital-raising efforts.*	
5	**National Entrepreneurial Culture**	4-5
	Learning Objectives: • *To gain knowledge of legal and regulatory requirements for startups, including compliance with relevant regulations.* • *To identify the various government initiatives to develop the start-up ecosystem.*	
	Contents: Entrepreneurial Ecosystem in India, Key regulations and legal aspects, Forms of Business Ownership, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc. Government incentives for entrepreneurship, Incubation, & Acceleration.	

	Learning Outcome: *The learner would be able to* • *Describe the current scenario of Entrepreneurial activity in India.* • *To state legal and regulatory requirements and compliances for start-ups.* • *To state the various government initiatives to support the entrepreneurs.*	
6	**Start-up Case Studies**	3-4
	***Learning Objectives**:* *To relate the real life case studies and analyse them for acquiring the clarity on various aspects of entrepreneurship covered in the first 5 modules*	
	Contents: Case Studies of various start-ups (with Indian Context): Start-ups from Tech, Edtech, Fintech, and Agriculture domain; Study of successful start-ups and failed start-ups.	
	Learning Outcome: • *To evaluate the real-world examples and case studies that will help them understand the practical aspects of idea to product, fundraising and financial management in the context of entrepreneurship.*	
7	***Course Conclusion***	1

In-semester Assessment - Continuous Assessment: Suggested

1 Teams of 3-4 students shall present a One-Minute business idea pitch– ideation phase-10 marks
2 Teams of 3-4 students shall present a Three-Minute Business Pitch –Validation phase-10 marks
3 Teams of 3-4 students shall present a Five-Minute Business Pitch for Funding- 15 marks
4 Teams of 3-4 students shall present analysis of one case study of successful or failed start-up- (15 Marks)

Course Outcome: Learner will be able to

CO1: State the concept of Entrepreneurship and Indian Start-up ecosystem
CO2: Identify the business ideas and to analyse the environment for potential business opportunity.
CO3: Identify the specific measures to design, test, and validate Minimum Viable Product.
CO4: State the key concepts, and strategies related to fundraising for entrepreneurial ventures.
CO4: Identify the legal and regulatory framework for entrepreneurs in Indian context.
CO5: Analyse and correlate the reasons for the success or the failure of entrepreneurial firms.

Text Books:

1. Poornima Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad

7. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.

Reference Books:

1. Zero to One: Notes on Startups, or How the Build the Future by Peter Thiel
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries
3. India as Global Start-up Hub: Mission with Passion by C B Rao
4. Innovation and Entrepreneurship: Practice and Principles by Peter F Drucker
5. Effective Entrepreneurial Management: Strategy, Planning, Risk Management, and Organization - Robert D. Hisrich, Veland Ramadani, Springer (2017)
6. Entrepreneurship- Theory, Process Practice –by Kuratko &Hodgetts, Thompson South-Western Publication

Relevant Websites:

1. www.msme.gov.in
2. www.dcmesme.gov.in
3. www.msmetraining.gov.in

Other Resources:

1. NPTEL Course: Entrepreneurship By Prof. C Bhaktavatsala Rao, IIT Madrao
   Weblink https://onlinecourses.nptel.ac.in/noc20_mg35/preview
2. NPTEL Course: Entrepreneurship Essentials By Prof. Manoj Kumar Mondal, IIT Kharagpur
   Weblink https://onlinecourses.nptel.ac.in/noc21_ge06/preview

Course Type	Course Code	Course Name	Credits
PCC	CEPCC611	CRYPTOGRAPHY AND SYSTEM SECURITY	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC408: Computer Network

Program Outcomes addressed:

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/development of solutions.
4. PO7: Ethics
5. PO11: Life-long learning.

Course Objectives:

1. To familiarize learners with the basic concepts of classical encryption techniques, modular arithmetic, and number theory.
2. To facilitate the learners to apply the concept of various cryptographic algorithms including key management and their roles providing different security services
3. To familiarize hashing and MAC techniques for providing integrity and message authentication security services.
4. To foster comprehensive knowledge about the different attacks on networks and security protocols like SSL, IPsec, and PGP.
5. To impart knowledge of the system security concept to recognize malicious code.

Module	Details	Hrs.
	Course Introduction Cryptography and system security are essential for computer engineering students, as they provide the foundation for protecting data, ensuring privacy, and securing digital communications. With rising cyber threats, mastering these fields is crucial for building resilient and trustworthy systems.	**01**
01.	**Introduction - Number Theory and Basic Cryptography** ***Learning Objective:*** *To explore classical encryption techniques and their role in data protection.*	**5-7**

	Contents: 1.1 Security Goals, Attacks, Services and Mechanisms, Techniques. Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem. 1.2 Classical Encryption techniques, Symmetric cipher model, Monoalphabetic and Polyalphabetic Substitution techniques: Vigenère cipher, Playfair cipher, Hill cipher, Transposition techniques: keyed and keyless transposition ciphers.	
	Self-Learning Topics: *Other encryption techniques, Chinese remainder theorem*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Use the principles of engineering to understand the basic concepts and fundamentals of system security. (P.I.-1.3.1), (P.I.-11.2.2)* *LO 1.2: Apply the basic concepts of number theory in cryptography. (P.I.-1.4.1)* *LO1.3: Compare different encryption techniques with the help of example. (P.I.-2.4.4)* *LO1.4: Use the appropriate encryption technique to decode given cipher text. (P.I.- 2.1.3)*	
02.	**Symmetric and Asymmetric key Cryptography and key management**	**7-9**
	Learning Objective: *To acquaint learners with cryptographic algorithms, key management techniques, and their role in cybersecurity.*	
	Contents: 2.1 Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC4 algorithm. 2.2 Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem, The knapsack cryptosystem. 2.3 Symmetric Key Distribution: Key management techniques: Diffie Hellman Key exchange algorithm, IKE.	
	Self-Learning Topics: *RC5, RC6*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Use the concept of symmetric key and public-key cryptography to solve the given problems. (P.I.-1.3.1)* *LO 2.2: Classify different modern cryptography techniques. (P.I.-1.4.1), (P.I.-11.2.2)* *LO 2.3: Identify symmetric (DES, AES, RC5), asymmetric key algorithms (RSA, Diffie Hellman) with benefits and limitations of different modes of operation for a block cipher. (P.I.-2.2.2), (P.I.-11.1.1)* *LO 2.4: Solve numerical problems based on the Diffie Hellman algorithm and IKE. (P.I.- 2.1.3).*	

03.	**Cryptographic Hash Functions and Digital Certificates** ***Learning Objective:*** *To explore different hashing and MAC techniques for providing integrity and message authentication security services* **Contents:** 3.1 Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC. 3.2 Digital Certificate: X.509 format, PKI ***Self-Learning Topics: SHA-256*** ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Identify the use of hash function and state the properties applications. (P.I.- 1.3.1), (P.I.-11.2.2)* *LO 3.2: Differentiate between different MD5, SHA1. (P.I.-1.4.1)* *LO 3.3: Use different MAC techniques, HMAC and CMAC and identify which one is better. (P.I.- 2.1.3)* *LO 3.4: Compare HMAC and CMAC Hash techniques (P.I.-2.4.4)*	**5-7**
04.	***Authentication Protocols & Digital Signature Schemes*** ***Learning Objectives:*** *To explore different User Authentication, Entity Authentication tech. to provide user authentication security service.* **Contents:** 4.1 User Authentication, Entity Authentication: Password Base, Challenge Response Based, Needham Schroeder Authentication protocol, Kerberos Authentication protocol. 4.2 Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA. ***Self-Learning Topics: Other Digital Signature Schemes*** ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Explore basic idea of user authentication techniques like password base, challenge response based. (P.I.-1.3.1), (P.I.-11.1.1)* *LO 4.2: Identify and categorize common attacks on Digital Signature Algorithms, such as replay attacks, key recovery attacks, and forgery. (P.I.-1.4.1)* *LO 4.3: Explore Digital Signature Scheme: RSA. (P.I.-3.2.1), (P.I.-11.2.2)* *LO 4.4: Solve numerical based on RSA Digital Signature Scheme to verify the functionalities and validate the results. (P.I.-3.4.3)*	**6-8**
05.	***Network Security and Applications*** ***Learning Objective/s:*** *To study different attacks on networks and security protocols like SSL, IPsec, and PGP.* **Contents:** 5.1 Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing.	**7-9**

	5.2 Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service. 5.3 Internet Security Protocols: PGP, SSL, IPSEC. Network security: IDS, Firewalls	
	Self-Learning Topics: Other Internet Security Protocols	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Identify TCP/IP vulnerabilities (Layer wise). (P.I.-2.2.2)* *LO 5.2: Explore different attacks on networks. (P.I.- 2.4.4), (P.I.-11.2.2)* *LO 5.3: Summarize different types of firewalls and IDS to provide security to network. (P.I.-1.3.1), (P.I.-11.1.1)* *LO 5.4: Summarize IP level Security protocol- IPsec, transport level security protocol - SSL, and email security protocol - PGP(P.I.-1.4.1), (P. 7.1.1), (P. 7.2.2)*	
06.	**System Security** ***Learning Objective/s:*** *Analyze and apply system security concept to recognize malicious code.*	**7-9**
	Contents: 6.1 Software Vulnerabilities: Buffer Overflow, Format string, cross- site scripting, SQL injection 6.2 Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.	
	Self-Learning Topics: Other types of malwares	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Explore malicious programs and types of malwares. (P.I.-1.3.1)* *LO 6.2: Comparison between different types of malwares. (P.I.-1.4.1)* *LO 6.3: Identify different measures taken to avoid presence of malware in a system. (P.I.-2.2.2), (P. 7.1.1), (P.I.-7.2.2)* *LO 6.4: Compare SQL injection and XSS in terms of attack vector, impact, and defense mechanisms. (P.I.- 2.4.4)*	
	Course Conclusion In this course, students will be able to apply theoretical knowledge of system security to practical scenarios.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply fundamental engineering concepts to solve computer engineering problems
2.2.2	Identifies functionalities and computing resources
2.4.4	Arrive at conclusions with respect to the objectives
3.2.1	Able to explore design alternatives.
3.4.3	Able to verify the functionalities and validate the design

7.1.1 Identify situations of unethical professional conduct and propose ethical alternatives

7.2.2 Examine and apply moral & ethical principles to known case studies

11.1.1 Describe the rationale for the requirement for continuing professional development.

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to -

1. Apply system security concepts and classical encryption techniques based on fundamental engineering and scientific principles. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Compare and apply encryption and decryption techniques for confidentiality using mathematical and computational models. *(LO 1.1, LO 1.4, LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Analyze cryptographic checksums and message digest algorithms through data analysis and mathematical modeling. *(LO 1.2, LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
4. Apply different digital signature algorithms to achieve authentication using engineering expertise and secure practices. *(LO 1.1, LO 1.2, LO 3.1, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
5. Analyze different attacks on networks and security protocols by leveraging research insights and critical analysis of cybersecurity threats. *(LO 1.1, LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
6. Apply system security concept to recognize malicious code while upholding ethical and professional responsibilities. *(LO 1.1, LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPCC611.1	3	2	-	-	-	-	-	-	-	-	2
CEPCC611.2	2	3	-	-	-	-	-	-	-	-	3
CEPCC611.3	3	2	-	-	-	-	-	-	-	-	2
CEPCC611.4	3	-	3	-	-	-	-	-	-	-	3
CEPCC611.5	3	3	-	-	-	-	3	-	-	-	3
CEPCC611.6	3	3	-	-	-	-	3	-	-	-	-
Average	**3**	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**

Textbooks:

1. Cryptography and Network Security, Principles and Practice, William Stallings, 6th Edition, March 2013, Pearson Education.
2. Cryptography & Network Security, Behrouz A. Ferouzan, 1st Edition, February 2007, Tata Mc Graw Hill
3. Cryptography and Network Security, Behrouz A. Forouzan & Debdeep Mukhopadhyay, 3rd Edition, 2015, Tata Mc Graw Hill

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier , Second Edition November 1995, Wiley.
2. Cryptography and Network Security, Atul Kahate, 4th Education, 2003, Tata McGraw-Hill Education.
3. Network Security Bible, Eric Cole, Second Edition,2011, Wiley.

Other Resources:

1. NPTEL Course: Cryptography and Network Security by Prof. D. Mukhopadhyay, Department of Computer Science and Engineering, IIT Kharagpur. Web Link: http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment-Theory (20 Marks)**

Suggested breakup of distribution

Two Class test: 05 marks each

Group discussion/public speaking/technical report writing: 05 Marks

Regularity and active participation: 05 Marks.

2. **Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50 % syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End semester examination will be based on syllabus coverage up to the Mid semester examination (MSE) carrying 20%-30% weightage and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC6021	MACHINE LEARNING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC301- Engineering Mathematics-III
2. CEPCC405- Engineering Mathematics-IV

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering tool usage
6. PO6: The Engineer and The World
7. PO9: Communication
8. PO11: Life-long learning

Course Objectives:

1. To familiarize learners with the basics of machine learning.
2. To guide learners to identify if the problem is a machine learning problem.
3. To introduce in depth concepts and working of various supervised and unsupervised machine learning approaches.
4. To guide learners to leverage the performance metrics to assess a machine learning model.
5. To facilitate the learners to apply various ensemble techniques for optimizing machine learning models.
6. To familiarize the dimensionality reduction techniques.

Module	Details	Hrs.
	Course Introduction: Learning machine learning is essential for leveraging data to drive innovation, improve decision-making, enhance efficiency, and stay competitive in various industries. A Machine Learning course equips computer engineering students with skills to design algorithms that enable systems to learn from data and make predictions or decisions. This foundational knowledge is crucial for developing innovative AI-driven applications in diverse domains like healthcare, finance, and robotics.	**01**

01.	**Introduction to Machine Learning** ***Learning Objectives:*** *Learners are expected to explore the basics of machine learning and be able to identify if the given problem is a machine learning problem or not and, in that case, identify the type of the problem and design the life cycle of machine learning model.*	**4-6**
	Contents: 1.1 Machine learning, Types of machine learning problems, Issues in ML, Strategy of machine learning 1.2 Applications of machine learning, Machine learning life cycle. 1.3 Training Error, Bias-Variance trade-off.	
	Self-Learning Topics: *Reinforcement Learning*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify the type of ML problem for the given scenario. (P.I. -2.1.2)* *LO 1.2: Define a precise the machine learning problem by analyzing the given scenario. (P.I.-3.1.1)* *LO 1.3: Design a machine learning life cycle for a given machine learning problem. (P.I. -3.2.1)* *LO 1.4: Analyze the effects of Bias and variance on given machine learning problem (P.I. 2.4.4)*	
02.	***Machine learning- Supervised Approach*** ***Learning Objective/s:*** *Learners are expected to identify* if *the* given *problem belongs to supervised approach and if so, which of the categories in particular- Regression or classification also they should be able to build the model and analyze on the basis of performance of the model.*	**10-12**
	Contents: 2.1 ***Regression*:** Linear Regression, Ridge Regression, Lasso Regression, Performance Metrics- Mean Squared Error (MSE). Root Mean Squared Error (RMSE). Mean Absolute Error (MAE). 2.2 ***Classification:*** Linear Classification, logistic Regression, Decision trees, Gini Index, CART- Classification and Regression trees, Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve. 2.3 Real world Case study : Stock price prediction, medical diagnosis.	
	Self-Learning Topics: *Autoregressive models, probabilistic classification*	

	Learning Outcomes: *A learner will be able to* *LO 2.1. Apply the concepts of statistics and theory of principles of machine learning to solve problems related to Machine learning (P.I. -1.1.1)* *LO 2.2: Apply theory and principles of computer science and engineering to solve an engineering problems related to supervised Machine learning (P.I. 1.4.1)* *LO 2.3 Compare and contrast alternate solutions to select the best fit model for given scenario on the basis of performance indicators by verifying using modern tools. (P.I. – 2.2.4, 4.1.2, 5.1.2, 11.1.2).* *LO 2.4 Design a model for real world case studies by analyzing feasibility of regression and classification. (P.I. – 3.2.2, 9.1.1, 9.1.2, 11.3.2).* *LO 2.5 Critically analyze data for trends and correlations for supervised problems, stating possible errors and limitations (P.I. 4.3.2, 6.3.1, 11.1.2)*	
03.	**Machine learning- Unsupervised Approach**	**7-9**
	Learning Objective: *Learners are expected to acquire basic knowledge about distance metrics and clustering and analyze how clusters are formed, by following various clustering techniques*	
	Contents: 3.1 Introduction to clustering- soft clustering, Hard clustering, Distance metrics 3.2 Basic Clustering approaches- K-means, Hierarchical, Fuzzy clustering. 3.3 Graph Based Clustering: Clustering with minimal spanning tree 3.4 Model based Clustering: Expectation Maximization Algorithm 3.5 Density Based Clustering: DBSCAN 3.6 Real world Case study: Fraud detection	
	Self-Learning Topics: *Clustering in high dimensional data*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Analyze the impact of the distance metrics and clustering to solve an Engineering problem. (1.4.1)* *LO 3.2: Identify the type of unsupervised machine learning approach for the given problem definition. (P.I. -2.1.2).* *LO 3.3: Explore the design alternatives for clustering for real world case studies. (P.I. -3.2.1).* *LO 3.4: Choose an appropriate experimental design plan for unsupervised approach based on the study objectives (P.I.-4.2.1)* *LO 3.5: Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions for unsupervised problems (P.I.-4.3.4, P.I.-9.1.1, P.I.- 9.1.2)*	
04.	**Support Vector Machines**	**6-8**
	Learning Objectives: *Learners are expected to apply the concept of support vector machines to find optimal boundary for classification.*	
	Contents: 4.1 Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, SVM for linear and nonlinear classification, Basics of Kernel trick. 4.2 Support Vector Regression, Multiclass Classification.	

	4.3 Real world Case study: E-mail classification.	
	Self-Learning Topics: *Kernel optimization, kernel machines*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the concepts of decision boundary and margins to solve an Engineering problem (P.I.-1.1.1)* *LO 4.2: Apply theory and principles of computer science and engineering to solve a classification problem using support vector machine (P.I. - 1.4.1)* *LO 4.3: Compare and contrast alternative methods to select the best classification methods (P.I. 2.2.4)* *LO 4.4: Identify design constraints of machine learning model with required applicability and performance for a given real world case study based on classification (P.I.-2.3.2)* *LO 4.5: Select the best fit classification model for given scenario on the basis of performance indicators by verifying using modern tools. (2.2.5, 5.1.2, 11.1.2)*	
05.	**Ensemble Learning** ***Learning Objective/s:*** *Learners are expected to optimize predictive modeling using ensembling techniques*	**6-8**
	Contents: 5.1 Ensemble concept, cross validation- validation set approach, leave p- out, leave one out, k-fold, stratified k fold, Hold out method 5.2 Boosting- Adaboost, Gradient boosting, Stumping, XGBoost, Catboost 5.3 Bagging, Sub bagging, Random Forest 5.4 Stacking, Blending 5.5 Hyperparameter optimization, Combining classifiers 5.6 Real world Case study: Heart attack Analysis and Prediction	
	Self-Learning Topics: *DECORATE Ensemble of ANN*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Identify the processes of ensemble method to solve a machine learning problems based on ensembling and cross validation. (P.I.-2.1.2)* *LO 5.2: Compare and contrast alternative methods for ensembling to select the best methods (P.I.- 2.2.4)* *LO 5.3: Produce potential design alternatives by applying the concepts of cross validation and ensembling for given case study. (P.I.-3.2.2)* *LO 5.4: Perform systematic evaluation of the problem to which several design constraints meet the criteria for ensembling and present the conclusions effectively (P.I.-3.3.1, 9.1.1, 9.1.2)*	
06.	**Dimensionality Reduction** ***Learning Objective/s:*** *Learners are expected to apply dimensionality reduction techniques to optimize the machine learning models.*	**4-6**
	Contents: 6.1 Curse of Dimensionality, Dimensionality Reduction Techniques, Principal Component Analysis	

	6.2 Feature Selection 6.3 Linear and nonlinear techniques for dimensionality Reduction	
	Self-Learning Topics: *Singular Value Decomposition*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply the knowledge of Linear Algebra to solve a PCA problem (P.I.-1.1.1)* *LO 6.2: Apply the concepts of principal Component analysis to solve a ML problem (P.I.- 1.4.1)* *LO 6.3: Identify mathematical algorithmic knowledge that applies to a given dimensionality reduction problem (P.I.-2.1.3)* *LO 6.4: Compare and contrast alternative methods for dimensionality reduction to choose appropriate method for the given scenario (P.I. 2.2.4)*	
	Course Conclusion: After completing a Machine Learning course, students will gain the ability to design data-driven models for prediction, classification, and decision- making. They will also develop analytical skills which will help them to implement ML algorithms across various domains, preparing them for advanced research and industry roles.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.1.3	Identify mathematical algorithmic knowledge that applies to a given problem
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.3.2	Identify design constraints for required performance criteria.
2.4.4	Arrive at conclusions with respect to the objectives.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.2.1	Able to explore design alternatives.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
3.3.1	Able to perform systematic evaluation of the degree to which several design concepts meet the criteria.
4.1.2	Able to choose appropriate procedure/algorithm, dataset and test cases.
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
4.3.2	Critically analyse data for trends and correlations, stating possible errors and limitations
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity

9.1.1 Read, understand and interpret technical and non-technical information

9.1.2 Produce clear, well-constructed, and well-supported written engineering documents

11.1.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Design life cycle of a machine learning experiment for a given scenario at a coarse granular level. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Design a strategy for building machine learning models such as regression, classification, and clustering for the given machine learning problem. *(LO 2.1, LO 2.2, LO 2.4, LO 3.1 to LO 3.5, LO 4.1, LO 4.2, LO 4.3)*
3. Analyse the performance of a supervised machine learning model using appropriate performance metrics. *(LO 2.3, LO 2.5, LO 4.4, LO 4.5)*
4. Design a strategy using various ensemble techniques to optimize a machine learning algorithm for the given problem. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Apply dimensionality reduction techniques to improve machine learning by enhancing performance. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC6021.1	-	3	3	-	-	-	-	-	-	-	-
CEPEC6021.2	3	3	3	3	-	-	-	-	3	-	2
CEPEC6021.3	-	3	-	3	2	2	-	-	-	-	2
CEPEC6021.4	-	3	3	-	-	-	-	-	3	-	-
CEPEC6021.5	3	3	-	-	-	-	-	-	-	-	-
Average	3	3	3	3	2	2	-	-	3	-	2

Text Books :

1. Peter Harrington, “Machine Learning n Action”, DreamTech Press
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill
3. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective”, CRC Press

Reference Books :

1. Han Kamber, ―Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2. Richard Duda, Peter Hart, David G. Stork, “Pattern Classification”, Second Edition, Wiley Publications.
3. Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education.

Other Resources :

1. https://www.coursera.org/learn/machine-learning
2. Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
3. UCI Machine Learning Repository
4. https://towardsdatascience.com/machine-learning/home

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. *Suggested breakup of distribution*

   Assignment on live problems/case studies, wherein problems are given prior. Students are expected to research and collect required resources. They can use the resources and solve the problem on assigned date and time in institute premises in presence of faculty member: 10 Marks.

   Group Discussions/Technical Report Writing: 05 Marks.
   Regularity and active participation: 05 Marks.

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC6022	BIG DATA ANALYTICS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

CEPCC304-Database Management System

Program Outcomes addressed:

PO1- Engineering knowledge

PO2- Problem analysis

PO3- Design/development of solutions

PO4-Conduct investigations of complex problems

PO5-Engineering Tool Usage

PO8-Individual and Collaborative Team Work

PO9-Communication

PO11-Life Long learning

Course Objectives:

1. To inculcate the concepts related to big data platforms, its use cases and Hadoop ecosystem.
2. To familiarize programming skills to build simple solutions using big data technologies such as Map Reduce
3. To familiarize with programming skills to build simple solutions using big data technologies like Scripting for No SQL
4. To instill the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability
5. To acquaint students with skills that will help them to solve complex real-world problems for decision support.
6. To guide the students to develop programs in R language for understanding and visualization of data using statistical, functions and plots

Module	Details	Hrs.
	Course Introduction The objective of this subject is to equip students with a comprehensive understanding of big data technologies, tools, and techniques. It aims to provide practical knowledge in managing, processing, and analyzing large-scale datasets using Hadoop, HDFS, MapReduce, and NoSQL databases. Students will gain expertise in stream data management, real-time data processing, and performance optimization for big data systems. Additionally, the course focuses on applying advanced analytics techniques, including recommendation systems, community detection, and data visualization using R. By the end of the course, students will be prepared to solve complex big data challenges, make data-driven decisions, and optimize solutions for real-world applications.	**01**
01.	**Introduction to Big Data &Hadoop:** ***Learning Objective:*** *Students are expected to familiarize and use the concepts of Big Data Analytics.*	**5-7**
	Contents: Introduction to Big data, Big Data Characteristics. Type of Big Data, Traditional vs. Big Data business approach Case Study of Big Data Solutions Hadoop Concept, Core Hadoop Components Hadoop Ecosystem and Hadoop Limitations.	
	Self-Learning Topics: *Case study related to big data fundamentals*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify key characteristics of big data relevant to specific problem scenarios. (P.I. -2.1.2)* *LO 1.2: Use the concept of big-data categorize given data into one of the big data types (P.I. -1.4.1)* *LO 1.3: Compare and contrast the fundamental differences between big data and traditional data approaches. (P.I. -2.2.4)* *LO 1.4: Select and recommend appropriate tools or technologies from the big data ecosystem to solve real-world challenges. (P.I. -2.1.2)* *LO 1.5: Evaluate the limitations and challenges associated with big data storage systems like HDFS. (P.I. -1.4.1)*	
02.	**Hadoop HDFS and Map Reduce:**	**6-8**
	Learning Objective: *Students are expected to use programming skills to build simple solutions using big data technologies such as Map Reduce*	

	Contents: Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization, the Map Tasks, grouping by Key, The Reduce Tasks, Combiners, Details of Map Reduce Execution. Coping with Node Failures, Algorithms using Map Reduce: Matrix vector multiplication by map reduce Relational Algebraic operations, Computing selection by Map Reduce, Computing Projection by Map reduce Set Operations using Map Reduce, Union, Intersection and Set Difference using map reduce Hadoop Limitation.	
	Self-Learning Topics: *Case study related to map reduce*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Solve the problem related to HDFS storage and Replication Analysis (P.I. -1.1.1)* *LO 2.2: Design a solution to solve problems such as word count, matrix operations, and set operations using Map Reduce programs (P.I. -3.4.1)* *LO 2.3: Use Combiners, Practitioners, and Distributed Caching technique to optimize MapReduce tasks (P.I. -2.3.1)* *LO 2.4: Apply mathematical principals to solve Map reduce tasks. (P.I. -1.3.1)* *LO 2.5: Apply DBS operation to solve map reduce task (P.I. -1.4.1)*	
03.	**NoSQL**	**7-9**
	Learning Objective: *Student are expected to analyze different No SQL solutions used in handling big data*	
	Contents: Introduction to NoSQL, NoSQL Business Drivers NoSQL Data Architecture Patterns: Key-value stores, Graph stores Column family (Big table) stores, Document stores variations of NoSQL architectural patterns, No SQL Case Study Understanding the types of big data problems, Analyzing big data with a shared-nothing architecture Choosing distribution models: master-slave versus peer-to- peer, four ways that NoSQL systems handle big data problems	
	Self-Learning Topics: *Case studies*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Compare and differentiate the characteristics and use cases of NoSQL and SQL databases (P.I. -2.2.4)* *LO 3.2: Evaluate the appropriateness of NoSQL and SQL databases for different applications based on given criteria (P.I. -3.3.1)* *LO 3.3: Identify and summarize key features of NoSQL databases (P.I. -1.4.1)* *LO 3.4: Compare consistency, availability, and partition tolerance for models in distributed systems (P.I. -2.4.4)* *LO 3.5: Analyze different NoSQL data architecture patterns. (P.I. -2.3.1)* *LO 3.6: Critically analyze the limitations of NoSQL databases, especially in critical applications. (P.I. -4.3.2)* *LO 3.7: Contrast different distribution models in database systems (1.3.1)*	

04.	**Mining Data Streams**	**7-9**
	Learning Objectives: *To acquire the fundamental techniques and principles in achieving big data analytic with scalability and streaming capability*	
	Contents: The Stream Data Model: A Data-Stream-Management System, Examples of Stream Source, Stream Queries, Issues in Stream Processing. Sampling Data techniques in a Stream, Filtering Streams: Bloom Filter with Analysis Counting Distinct Elements in a Stream, Count Distinct Problem Flajolet-Martin Algorithm Combining Estimates, Space Requirements ,Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm , Query Answering in the DGIM Algorithm, Decaying Windows	
	Self-Learning Topics: *Case study related to data stream management system*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Designing Stream Data Management Systems for specific platform (P.I. -3.2.2)* *LO 4.2: Implement a solution real time Stream Queries and Data Sampling Techniques (P.I. -2.1.2)* *LO 4.3: Apply Optimizing Space and Memory Efficiency in Stream Processing (P.I. -1.3.1)* *LO 4.4: Designing Scaling Stream Processing Systems for Large-Scale Data (P.I. -4.2.1, P.I. -5.1.1, P.I. -8.2.1,PI-11.3.2)* *LO 4.5: Design Real-Time Query Processing system for specific system using modern tools (P.I. -3.3.2, P.I. -5.1.2, P.I. -11.3.1)* *LO 4.6: Apply Query Answering and Performance algorithm (P.I. -1.4.1)* *LO 4.7: Apply Anomaly Detection in Streams (P.I. -1.3.1)* *LO 4.8:Demonstrate algorithms using discipline specific tools(P.I. -5.2.2)*	
05.	**Real Time Big Data Models**	**6-8**
	Learning Objective/s: *students to have skills that will help them to solve complex real-world problems for decision suppor***t**	
	Contents: A Model for Recommendation Systems ,Content-Based Recommendations, Collaborative Filtering Case Study: Product Recommendation, Social Networks as Graphs, Clustering of Social-Network, Graphs, Direct Discovery of Communities in a social graph	
	Self-Learning Topics: Nil	
	Learning Outcomes :	
	A learner will be able to *LO 5.1: Design a content-based approach and collaborative filtering for re commander systems (P.I. -4.2.1, P.I. -11.3.1, P.I. -8.3.1,PI -9.1.3)* *LO 5.2: Apply clustering techniques that can be used for community detection in a social graph (P.I. -2.1.2)* *LO 5.3: Apply algorithms for direct discovery of communities in a social network (P.I. -2.1.1)*	

	LO 5.4: Analyze various stream sampling techniques and provide valuable justification (P.I. -2.2.3) *LO 5.5: Apply the concept of Blooms filter to solve given stream of data (P.I. -1.4.1)*	
06.	**Data Analytics with R** ***Learning Objective/s:*** *Develop programs in R language for understanding and visualization of data using statistical, functions and plots* **Contents:** Exploring Basic features of R, Exploring RGUI, Exploring RStudio ,Handling Basic Expressions in R Variables in R, Working with Vectors, Storing and Calculating Values in R Creating and using Objects interacting with users, Handling data in R Workspace Executing Scripts, Creating Plots, Accessing help and documentation in R ***Self-Learning Topics:*** *Solving more problems with programmed approach* ***Learning Outcomes :*** *A learner will be able to* *LO 6.1: Apply various basic plots for given problem (P.I. -1.4.1)* *LO 6.2: Analyze dataset and querying of the dataset using R script and functions. (P.I. -2.4.2)* *LO 6.3: Analyze various visualization types and their application* (*P.I.* -1.3.1) *LO 6.4: Design a solution to big data problems using modern tools (P.I. -4.1.2, P.I. -5.2.2, P.I. -8.2.1, P.I.9.1.1,PI-11.3.1)* *LO 6.5:Use R programming to handle Expressions(P.I. -1.4.1)* *LO 6.7: Apply various basic plots for given problem with programming approach demonstrate with innovative method (P.I. -5.1.1, P.I. -8.3.1, P.I. -9.1.3)*	**6-8**
	Conclusion This course provides a thorough exploration of big data technologies, starting with key concepts such as big data characteristics, types, and how it contrasts with traditional data. Students gain practical skills in utilizing Hadoop, HDFS, and MapReduce, with a focus on performance optimization techniques. The NoSQL module equips learners with the knowledge to choose the appropriate database architecture for specific applications. Emphasis on stream data management, real-time querying, and space optimization prepares students to handle large-scale data systems. The course also covers real-time big data models like recommendation systems and community detection in social networks. By the end, students will be adept at managing, analyzing, and visualizing big data, applying their skills to solve complex, real-world challenges	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrastdifferent methods based on certain criteria
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance]
2.4.3	Identify the limitations of the solution and sources/causes.
2.4.4	Arrive at conclusions with respect to the objectives.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
3.3.1	Able to perform systematic evaluation of the degree to which several design concepts meet the criteria
3.3.2	Able to provide an optimal solution that meets the criteria
3.4.1	Able to provide design solution to given problem using specific techniques
4.1.2	Able to choose appropriate procedure/algorithm, dataset and test cases.
4.2.1	Design and develop appropriate procedures/methodologies based on the study objectives
4.3.2	Critically analyze data or application based on certain criteria stating possible errors and limitations
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.1.1	Read, understand and interpret technical and non-technical information
9.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
11.3.1	Source and comprehend technical literature and other credible sources of information
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1 Design a system to analyse real-time big data by applying the fundamental principles of big data and its associated technologies. *(LO 1.1,LO 1.2,LO1.3,LO 2.1,LO2.2,LO 2.3,LO 2.4,LO 6.5,LO 3.2)*

2 Apply advanced tools and architectures for storing, processing and managing big data efficiently. *(LO 1.4,,LO 3.3,LO 3.7,LO 2.5,LO 5.4.LO 5.5)*

3 Design strategies for managing data storage, retrieval, and processing in a distributed environment

(LO 1.5,LO 3.1,LO3.4,LO3.5,LO 4.4,LO4.7,LO5.1,LO6.4,LO 4.8)

4 Designing a solution to complex real-world problems for decision support

(LO 4.1,LO 4.2,LO 4.3,,LO 4.5,LO4.6,LO 5.2,LO 3.6,LO 6.7)

5 Utilize data analytics and visualization tools to process and analyse large-scale data sets.

(LO 5.3,LO 6,1,LO 6.2,LO 6.3,LO 6.5)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC6022.1	3	3	3								
CEPEC6022.2	3	3									
CEPEC6022.3	3	3		3	3			3	3		3
CEPEC6022.4	3	3	3	3	3			3	3		3
CEPEC6022.5	3	3									
Average	**3**	**3**	**3**	**3**	**3**			**3**	**3**		**3**

Text Books :

1. Cre Anand Rajaraman and Jeff Ullman, “Mining of Massive Datasets”, Cambridge University Press.
2. Dan McGary and Ann Kelly, “Making Sense of NoSQL – A guide for managers and the rest of us”, Manning Press
3. DT Editorial Services, “Big Data Black Book”, Dreamtech Press

Reference Books :

1. Bill Franks, “Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Bill Franks
2. Jared Dean, “Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners”, 2014,Wiley India Private Limited
3. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, 3rd edition, Morgan Kaufmann Publications.
4. Radha Shankarmani, “Big Data Analytics”, Wiley Publication.
5. Anil Maheshwari, “Big Data”, Mc Graw Hill Publications.

Other Resources :

1. NPTEL Course: Big Data Computing By Prof. Rajiv Mishra, Department of Computer Science Engineering, IIT Patna :-Web link- https://onlinecourses.nptel.ac.in/noc20_cs92/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

1. *Suggested breakup of distribution*

   Assignment on live problems/case studies, wherein problems are given prior. Students are expected to research and collect required resources. They can use the resources and solve the problem on assigned date and time in institute premises in presence of faculty member: 10 Marks.

   Group Discussions/Technical Report Writing: 05 Marks.
   Regularity and active participation: 05 Marks.

2. **Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC6023	ADVANCED NETWORKS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC408: Computer Network

Program Outcomes addressed:

1. PO1: Engineering knowledge.
2. PO2: Problem analysis.
3. PO3: Design/development of solutions.
4. PO7: Ethics
5. PO11: Life-long learning.

Course Objectives:

1. To impart a fundamental understanding of advanced computer networks.
2. To acquaint learners with the fundamental concepts of network technologies and their application in real-life scenarios.
3. To explore various internetworking routing protocols used in distributed systems
4. To familiarize learners with emerging trends and their application in real-time scenarios.

Module	Details	Hrs.
	Course Introduction Advanced network models are crucial for computer engineering students, as they integrate technical knowledge with efficient data transmission and communication. Their importance lies in supporting modern applications like streaming, video conferencing, and online gaming by ensuring optimized performance, reliability, and security in complex networking environments.	**01**
01.	**Networking Models & Protocols**	**5-7**
	Learning Objective: *To explore the fundamentals of computer engineering and learn the concepts of advanced computer networks and their requirements for real-life applications.*	
	Contents: OSI reference model, TCP/IP reference model, ATM reference model;	

	Applications (WWW, Audio/Video Streaming, Video conference, Networked Games, Client/Server); Traffic Characterization (CBR, VBR); Switching Paradigms; Multiplexing; Error Control; Flow Control, FTH, DTH, PON, ISDN, DSL, CATV, SONET. ***Self-Learning Topics:*** *Optical Networks* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Use the computer engineering concept to identify the roles of different modern networking technologies. (P.I.-1.3.1), (P.I.-11.1.1)* *LO 1.2: Use the principles of engineering to understand the basic concepts and fundamentals of advanced computer networks useful in the future. (P.I.-1.4.1), (P.I.-11.2.2)* *LO1.3: Compare different reference models (OSI, TCP/IP, and ATM) and conclude which model is more suitable for modern networking environments considering their performance. (P.I.-2.4.4),* *LO 1.4: Identify the key functionalities of optical networks and explain how (WDM) technology enhances data transmission capacity. (P.I.-2.2.2)*	
02.	**Local Area Network Technologies** *Learning Objective:* *To introduce different Local Area Network (LAN) technologies and their functionalities.* **Contents:** Fast Ethernet, Gigabit Ethernet, IEEE 802.11 WLAN, Bluetooth, Connecting LANs, VLANS. ***Self-Learning Topics: VLAN Security*** ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Use the computer engineering concept to explore wireless network standards, security, and performance factors. (P.I.-1.3.1), (P.I.-11.1.1)* *LO 2.2: Apply computer engineering fundamentals to understand the concepts VLAN tagging (802.1Q) and inter-VLAN routing for efficient network management. (P.I.-1.4.1)* *LO 2.3: Compare Bluetooth and Wi-Fi technologies in terms of range, data rates, and typical applications. Which technology is more appropriate for IoT devices and personal area networks (P.I.-2.4.4), (P.I.-11.2.2)* *LO 2.4: Apply engineering fundamentals to decide between wired and wireless solutions for specific business needs. (P.I.-2.2.2), (P.I.- 7.2.2)*	**7-9**
03.	**Internetworking** ***Learning Objective:*** *To explore different internetworking routing protocols.* **Contents:** Interdomain Routing, BGP, IPv6, Multicast Routing Protocols, Multi-Protocol Label Switching, Virtual Private Networks, High speed transport protocols, Quality of Service Mechanisms, Improving QoS in	**5-7**

	Internet, DiffServ and IntServ Architectures.	
	Self-Learning Topics: RSVP	
	Learning Outcomes: *A learner will be able to* *LO 3.1 Use the concepts of computer engineering to summarize Interdomain Routing Protocols. (P.I.-1.4.1)* *LO 3.2: Use the principles of engineering to gain a deep understanding of various routing protocols and traffic management techniques to efficiently manage and optimize data flow across different network domains. (P.I.-1.3.1)* *LO 3.3: Design and implement securely to connect remote encryption, integrity, scalability, and optimal performance across diverse geographical locations. and verify the functionalities. (P.I.-3.4.3)* *LO 3.4: Compare DiffServ and IntServ architectures to manage traffic flows. Choose the most appropriate model based on based on network functionalities. (P.I.-2.4.4)* *LO 3.5 Apply classful vs. classless addressing and determine which design best meets network requirements for different use cases to explore design alternatives. (P.I.-3.2.1), (P.I.- 7.2.2), (P.I.- 7.2.2)* *LO3.6 Summarize the core functionalities of MPLS and explain how it enhances traffic engineering, QoS, and scalability in modern networks. (P.I.-2.2.2)*	
04.	**Distributed Systems**	**6-8**
	Learning Objectives: *To explore different Distributed Systems*	
	Contents: Naming, DNS, Paradigms for Communication in Internet, Caching, Issues of Scaling in Internet and Distributed Systems, Caching Techniques for Web, Protocols to Support Streaming Media, Multimedia Transport Protocols, Content Delivery Networks, Overlay and P2P Networks.	
	Self-Learning Topics: Other caching techniques	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Use the engineering fundamentals to summarize the role of DNS and DDNS in the Internet's naming system (P.I.-1.3.1)* *LO 4.2: Identify the challenges of scaling caching systems in large-scale distributed networks. (P.I.-2.2.2)* *LO 4.3: Compare client-server, peer-to-peer (P2P), and publish-subscribe paradigms for Internet communication and conclude with respect to the given objectives. (P.I.-2.4.4)* *LO 4.4: Apply fundamental engineering concepts of Content Delivery Network (CDN) principles to enhance the performance of a global news website. (P.I.-1.4.1). (P.I.- 7.1.1), (P.I.- 7.2.2)*	
05.	**Other Networking Technologies and Applications**	**7-9**
	Learning Objective/s: *To study different Other Networking Technologies and Applications.*	
	Contents: RTP, RTSP, SIP, VoIP, Ad-hoc, MANET, VANET: Network Basics	

	Characteristics, applications, challenges, Architecture	
	Self-Learning Topics: SDN	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Use the engineering fundamentals to summarize RTP and its role in delivering real-time multimedia data over the Internet. (P.I.-1.3.1)* *LO 5.2: Identify the functionalities and computing resources used in practical applications of MANETs and VANETs in fields such as disaster recovery, military operations, and smart transportation systems etc. (P.I.-2.2.2),(P.I.11.2.2)* *LO 5.3: Compare Ad-hoc networks, MANETs, and VANETs in terms of architecture, scalability, mobility and conclude with respect to the given objectives. (P.I.-2.4.4)* *LO 5.4: Apply fundamental characteristics of RTP, RTSP, SIP, and VoIP protocols in real-time communication. (P.I.-1.4.1)*	
06.	**Emerging Trends and Applications** ***Learning Objective/s:*** *To study emerging trends and applications Integrated to 5G and IoT.*	**7-9**
	Contents: Integration with 5G and IoT: Role of MANET/VANET in 5G networks, IoT edge devices in wireless networks. Edge and Cloud Computing in Wireless Networks: Resource allocation, latency reduction, and data offloading. Simulation Tools: NS-3, Mininet for SDN, SUMO for VANET simulation.	
	Self-Learning Topics: Other Simulation Tools	
	Learning Outcomes: *A learner will be able to* *LO6.1: Use the engineering fundamentals to summarize the role of MANET/VANET in 5G networks role. (P.I.-1.3.1)* *LO 6.2: Identify the functionalities and computing resources required while using different simulation tools (P.I.-2.2.2)* *LO 6.3: Compare MANETs, and VANETs in 5G networks and specify which one is better. (P.I.-2.4.4)* *LO 6.4: Apply fundamental simulation tools for real-time applications. (P.I.-1.4.1), (P.I.-11.1.1),(P.I.-11.2.2)*	
	Course Conclusion In this course, students will be able to apply theoretical knowledge of Advanced computer network to practical scenarios.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply fundamental engineering concepts to solve computer engineering problems
2.2.2	Identifies functionalities and computing resources
2.4.4	Arrive at conclusions with respect to the objectives
3.2.1	Able to explore design alternatives.

3.4.3 Able to verify the functionalities and validate the design

4.2.1 Design and develop appropriate procedures/methodologies based on the study objectives

4.3.1 Use appropriate procedures, tools, and techniques to collect and analyse data

7.1.1 Identify situations of unethical professional conduct and propose ethical alternatives

7.2.2 Examine and apply moral & ethical principles to known case studies

11.1.1 Describe the rationale for the requirement for continuing professional development.

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to -

1. Apply different network architectures and protocols to real-life applications by leveraging fundamental engineering principles and systematic theory-based knowledge. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Analyze and optimize LAN and VLAN technologies based on computing principles to enhance network performance and security. *(LO 1.1, LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Apply internetworking concepts and improve QoS in networks by integrating engineering expertise and resource-efficient design principles. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4. LO 3.5, LO 3.6)*
4. Analyze various solutions for distributed systems and their scalability issues using research-based knowledge and critical thinking. (*LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
5. Compare types of networks with reference to their functionalities and societal impact while incorporating sustainability and professional responsibilities. *(LO 1.1, LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
6. Analyze advanced networking applications and emerging trends using research literature and problem-solving methodologies. *(LO 1.1, LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC6023.1	3	3	-	-	-	-	-	-	-	-	3
CEPEC6023.2	3	3	-	-	-	-	2	-	-	-	3
CEPEC6023.3	3	3	3	-	-	-	3	-	-	-	-
CEPEC6023.4	3	3	-	-	-	-	3	-	-	-	-
CEPEC6023.5	3	3	-	-	-	-	-	-	-	-	2
CEPEC6023.6	3	3	-	-	-	-	-	-	-	-	3
Average	**3**	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**3**

Text Books:

1. Data Communications and Networking, Behrouz A. Forouzan, 5th Edition,2013, Tata McGraw Hill.
2. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems approach, 4th edition, 2007, Morgan Kaufmann.
3. J. Walrand and P. Varaiya, High Performance Communication Networks,2nd edition, 2000, Morgan Kaufmann.

   Markus Hoffmann and Leland R. Beaumont, Content Networking: Architecture, Protocols and Practice, 2005, Morgan Kauffman.

Reference Books:

1. Distributed Computing: Principles, Algorithms, and Systems, Kshemkalyani, A. D., and Singhal, M., 1st Edition, 2008, Cambridge University Press.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., and Henry, J., 1st Edition, 2017, Cisco Press.
3. 5G Mobile and Wireless Communications Technology, Osseiran, A., Monserrat, J. F., and Marsch, P., 1st Edition, 2016, Cambridge University Press.

Other Resources:

1. NPTEL Course: Advanced Computer Networks by Prof. Neminath Hubballi, Prof. Sameer G Kulkarni, Department of Computer Science and Engineering, IIT Indore, IIT Gandhi Nagar, Web Link: **https://onlinecourses.nptel.ac.in/noc23_cs35/preview**

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment-Theory (20 Marks)**

   Suggested breakup of distribution

   Two Class test: 05 marks each

   Group discussion/public speaking/technical report writing: 05 Marks

   Regularity and active participation: 05 Marks.

2. **Mid Semester Exam (30 Marks)**

Mid semester examination will be based on 40% to 50 % syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End semester examination will be based on syllabus coverage up to the Mid semester examination (MSE) carrying 20%-30% weightage and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC6024	HIGH PERFORMANCE COMPUTING	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. CEPCC407-Operating System

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO5: Engineering Tool Usage
4. PO8: Individual and Collaborative Team work
5. PO9: Communication
6. PO11: Life-long learning

Course Objectives:

1. Enable students to understand, classify, and evaluate parallel computing and its architectures.
2. Prepare students to analyze, design, and optimize pipeline and parallel computing systems, focusing on performance metrics, architectural models, and trends.
3. Train students to design, analyze, and optimize parallel algorithms, emphasizing decomposition techniques, load balancing, and interaction overhead.
4. Guide students to measure, analyze, and optimize the performance and scalability of parallel systems.
5. Provide students with a comprehensive understanding of message passing programming principles to develop, analyze, and optimize high-performance computing applications using MPI and OpenMP, while fostering communication, problem-solving, and teamwork skills.

Module	Details	Hrs
	Course Introduction The High-Performance Computing (HPC) course introduces parallel computing concepts, programming paradigms, performance optimization, and memory models, enabling students to develop efficient parallel applications using MPI and OpenMP for problem-solving.	**01**
01.	**Introduction to High Performance Computing:** ***Learning Objective/s:*** *Understand the fundamental principles and classification models of high performance computing.*	**5-7**

	Contents: 1.1. Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function) 1.2. Classification Models: Architectural Schemes (Flynn's, Shore's, Feng's, Handler's) and Memory access (Shared Memory, Distributed Memory, Hybrid Distributed Shared Memory) 1.3. Parallel Architectures: Pipeline Architecture, Array Processor, Multiprocessor Architecture, Systolic Architecture, Data Flow Architecture	
	Self-Learning Topics: Parallelism and Its Potential in HPC	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply the knowledge of discrete structures and numerical techniques to understand the fundamentals of parallel computing, including the motivation and scope of parallelism. (P.I. 1.1.1)* *LO 1.2: Apply engineering fundamentals to classify and compare different architectural schemes and memory access models in parallel computing. (P.I. 1.3.1)* *LO 1.3: Evaluate problem statements related to parallel computing, identify objectives, and determine the appropriate levels of parallelism (instruction, transaction, task, thread, memory, function) to optimize performance. (P.I. 2.1.1)* *LO 1.4: Identify functionalities and computing resources required for implementing various parallel architectures, such as pipeline, array processor, multiprocessor, systolic, and data flow architectures, and assess their effectiveness in real-world applications. (P.I. 2.2.2)*	
02.	**Pipeline Processing** ***Learning Objective/s:*** *Learner is expected to familiarize with the concepts of pipeline processing, analyze pipeline performance, arithmetic pipelines, instruction processing, and stage design, and evaluate the impact of instruction scheduling on execution efficiency.*	**7-9**
	Contents: 2.1. Introduction, Pipeline Performance, Arithmetic Pipelines, 2.2. Pipeline instruction processing, Pipeline stage design, Hazards, Dynamic instruction scheduling	
	Self-Learning Topics: Speculative Execution in Modern Processors	
	Learning Outcomes: A learner will be able to *LO 2.1: Apply theoretical principles of computer science and engineering to understand pipeline performance and arithmetic pipelines, demonstrating effective communication and problem-solving skills, and interpreting technical information accurately. (P.I. 1.4.1, 8.2.1, 9.1.1)* *LO 2.2: Apply engineering fundamentals to design pipeline instruction processing stages, identify and resolve hazards, and present results as a team with clear, well-constructed documentation. (P.I. 1.3.1, 8.3.1, 9.1.2)* *LO 2.3: Compare and contrast various dynamic instruction scheduling methods to select the most efficient process for optimizing pipeline performance. (P.I. 2.2.4)* *LO 2.4: Identify design constraints for required performance criteria in pipeline stage design and evaluate their impact on overall system performance. (P.I. 2.3.2)*	

03.	**Parallel Programming Platforms**	**5-7**
	Learning Objective/s: *Learner is expected to understand implicit parallelism, analyze trends in microprocessor architectures, evaluate memory performance limitations, explore parallel computing platforms, and assess communication costs in parallel machines for efficient system design.*	
	Contents: 3.1. Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor & Architectures, Limitations of Memory System Performance. 3.2. Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines.	
	Self-Learning Topics: CUDA and GPU Computing for Parallel Processing	
	Learning Outcomes: *LO 3.1: Apply engineering fundamentals to understand the limitations of memory system performance and the physical organization of parallel platforms. (P.I. 1.3.1)* *LO 3.2: Apply theoretical principles of computer science and engineering to analyze implicit parallelism and communication costs in parallel machines, demonstrating a comprehensive understanding of parallel programming platforms. (P.I. 1.4.1)* *LO 3.3: Evaluate problem statements related to parallel programming platforms, identify objectives, and recognize the importance of staying current with trends in microprocessor architectures and memory system performance. (P.I. 2.1.1, 11.2.2)* *LO 3.4: Compare and contrast various parallel computing platforms and their physical organization, analyze communication costs in parallel machines, and assess the feasibility, viability, and sustainability of different parallel computing solutions. (P.I. 2.2.4, 11.3.2)*	
04.	**Parallel AlgorithmDesign**	**6-8**
	Learning Objective/s: *Learner is expected to familiarize with the principles of parallel algorithm design, including decomposition techniques, task interactions, load balancing, interaction overhead management, and parallel algorithm models for efficient execution.*	
	Contents: 4.1. Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, 4.2. Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models	
	Learning Outcomes: ***A learner will be able to*** *LO 4.1: Apply engineering fundamentals to understand the principles of parallel algorithm design, including decomposition techniques and characteristics of tasks and interactions. (P.I. 1.3.1)* *LO 4.2: Apply theoretical principles of computer science and engineering to develop and analyze parallel algorithm models, ensuring effective load balancing and interaction overhead containment. (P.I. 1.4.1)* *LO 4.3: Evaluate problem statements related to parallel algorithm design, identify objectives, and determine appropriate mapping techniques for load balancing. (P.I. 2.1.1)*	

	LO 4.4: Identify functionalities and computing resources required for implementing parallel algorithms, and assess methods for containing interaction overheads to optimize performance. (P.I. 2.2.2)	
05.	**Performance Measures** ***Learning Objective/s:*** *Learner is expected to familiarize with the performance measures in parallel computing, including speedup, execution time, efficiency, cost, scalability, granularity effects, scalability models, and performance laws like Amdahl's and Gustavson's to identify bottlenecks and optimize system performance.* **Contents:** 5.1. Performance Measures: Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, 5.2. Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks ***Self-Learning Topics:*** *Roofline Model for Performance Analysis in HPC* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Apply the knowledge of discrete structures and numerical techniques to measure performance metrics such as speedup, execution time, efficiency, cost, and scalability, demonstrating effective communication and problem-solving skills, and interpreting technical information accurately. (P.I. 1.1.1, 8.2.1, 9.1.1)* *LO 5.2: Apply theoretical principles of computer science and engineering to analyze the scalability of parallel systems, including Amdahl's Law and Gustavson's Law, and present results as a team with clear, well-constructed documentation. (P.I. 1.4.1, 8.3.1, 9.1.2)* *LO 5.3: Compare and contrast various performance bottlenecks and methods to improve scalability, selecting the most efficient process for optimizing parallel system performance. (P.I. 2.2.4)* *LO 5.4: Identify design constraints for required performance criteria in parallel systems and evaluate their impact on overall system performance, considering the effect of granularity on performance. (P.I. 2.3.2)*	**7-9**
06.	**HPC Programming** ***Learning Objective/s:*** *Learner is expected to familiarize with the principles of message-passing programming, MPI fundamentals and the basics of OpenMP and OpenMPI for efficient parallel programming.* **Contents:** 6.1. Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming 6.2. The Building Blocks: Send and Receive Operations 6.3. MPI: Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, 6.4. Introduction to OpenMP, OpenMPI 6.5. Case Studies: HPC in scientific Computing, HPC in Machine learning and AI, HPC in Big data analytics. ***Self-Learning Topics:*** *OpenMP Programming for Multi-Core Systems*	**7-9**

	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply the knowledge of discrete structures and numerical techniques to understand the principles of message passing programming, demonstrating effective communication and problem-solving skills, and interpreting technical information accurately. (P.I. 1.1.1, 8.2.1, 9.1.1)* *LO 6.2: Apply theoretical principles of computer science and engineering to develop and analyze message passing programs using MPI, ensuring effective team collaboration, proficiency in using discipline-specific tools, and producing clear, well-constructed documentation. (P.I. 1.4.1, 5.2.2, 8.3.1, 9.1.2)* *LO 6.3: Compare and contrast various message passing techniques and tools, such as MPI and OpenMP, to select the most efficient methods for overlapping communication with computation, while recognizing the importance of staying current with new developments in the field. (P.I. 2.2.4, 5.1.1, 11.2.2)* *LO 6.4: Identify design constraints for required performance criteria in high-performance computing applications, evaluate their impact on overall system performance, and analyze sourced technical information for feasibility, viability, and sustainability. (P.I. 2.3.2, 5.2.2, 11.3.2)*	
	Course Conclusion: The High-Performance Computing (HPC) course equips students with fundamental and advanced concepts of parallel computing, algorithm design, performance optimization, and programming paradigms like MPI and OpenMP. Students gain hands-on experience in designing scalable, efficient, and high-performance parallel applications for real-world problems.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to solve problems.
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem.
2.1.1	Evaluate problem statements and identifies objectives
2.2.2	Identify functionalities and computing resources.
2.2.4	Compare and contrast alternative solution/methods to select the best methods.
2.2.5	Compare and contrast alternative solution processes to select the best process.
2.3.2	Identify design constraints for required performance criteria.
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.2.2	Demonstrate proficiency in using discipline-specific tools
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and non-technical information

9.1.2 Produce clear, well-constructed, and well-supported written engineering documents

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

11.3.2 Analyse sourced technical and popular information for feasibility, viability, sustainability etc.

Course Outcomes: A learner will be able to -

1. Apply mathematical foundations and core principles to evaluate parallel computing models, assess problems, and determine necessary computing resources. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4)*
2. Apply core principles and theoretical concepts to enhance pipeline performance, design parallel computing platforms in a team and present effectively. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Develop and analyze parallel algorithm models using core principles, assess problems, and determine necessary computing resources to remain in tune with current technologies. *(LO 3.1, LO 3.2, LO3.3, LO 3.4, LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Assess and optimize parallel system performance using mathematical foundations, fostering a lifelong learning mind-set to adapt to evolving computational challenges. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Develop message passing programs using parallel computing principles and evaluate design constraints to optimize system performance, demonstrating proficiency in technical communication and collaboration to foster lifelong learning in the evolving field of high-performance computing. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC6024.1	3	3	-	-	-	-	-	-	-	-	-
CEPEC6024.2	3	3	-	-	-	-	-	3	3	-	-
CEPEC6024.3	3	3	-	-	-	-	-	-	-	-	3
CEPEC6024.4	3	3	-	-	-	-	-	-	-	-	3
CEPEC6024.5	-	-	-	-	3	-	-	-	-	-	3
Average	3	3	-	-	3	-	-	3	3	-	3

Reference Books :

1. Michael J. Quinn - *Parallel Programming in C with MPI and OpenMP*, McGraw-Hill, 2008.
2. Kai Hwang, Zhiwei Xu - *Scalable Parallel Computing: Technology, Architecture, Programming*, McGraw Hill, 1998.
3. Laurence T. Yang, Minyi Guo - *High-Performance Computing: Paradigm and Infrastructure*, Wiley, 2006.

Other Resources :

1. NPTEL – High Performance Computing – http://nptel.ac.in/courses/106/108/106108055
2. Swayam – Parallel and Distributed Computing – http://swayam.gov.in/explorer?searchText=Parallel%20Computing
3. Coursera – Parallel Programming with MPI – http://www.coursera.org/learn/parallel-programming-mpi
4. MPI Benchmarks and Tutorials – http://github.com/mpitutorial/mpitutorial

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution
Class Test 1: 05 Marks

Class Test 2: 05 Marks

Article reading and summarization: 05 Marks

Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
LBC	CELBC608	SYSTEM SECURITY LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total**
25	25	50

Pre-requisites:

ESL205- Programming Laboratory –II (Java)

CEPCC408- Computer Network

CE SBL301- Python Programming Laboratory

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Engineering tool usage
5. PO7: Ethics
6. PO11: Lifelong learning

Course Objectives:

1. Apply the knowledge of symmetric cryptography to implement classical ciphers
2. To develop 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 to resolve them.

Module	Detailed Contents	Hrs.
	Course Introduction: System security lab provides a comprehensive understanding of cryptographic techniques and system security measures, offering both theoretical foundations and practical applications.	**01**

01.	***Learning Objectives:*** 1. *Expected to perform encryption and decryption of a given plain text using classical cipher.* **Classical Encryption techniques** **Laboratory Exercises: (Suggested Tasks):** Implementation of Caesar Cipher (shift-based), Playfair Cipher (digraph-based), Rail Fence Cipher (zigzag pattern) and Columnar Transposition Cipher (keyword-based column ordering) for secure message encryption. Combine substitution (Caesar/Playfair) and transposition (Rail Fence /Columnar) to create a stronger encryption scheme. Generate ciphertext and decrypt it back to plaintext, ensuring accuracy of encryption and decryption operations. Analyze weaknesses using frequency analysis, brute-force attacks, and decryption without a key to test cipher robustness. Use cryptographic tools to validate the correctness of encryption outputs and compare with implemented algorithms.	**4-6**
	Learning Outcomes: *A learner will be able to* *LO 1.1: Demonstrate the ability to explore different classical ciphers, implement substitution and transposition ciphers using Java or Python, and utilize online tools to generate and verify ciphertext, ensuring accuracy and security of the output (PI: 2.1.2, 2.4.2, 3.2.1, 3.4.2, 5.1.1, 5.2.2)* *LO 1.2: Validate and analyze the security of classical ciphers by performing cryptanalysis, testing encryption strength, and comparing cipher effectiveness using frequency analysis and other evaluation techniques. (PI: 4.1.1, 4.3.1, 5.2.2)*	
02.	***Learning Objective:*** *Expected to use open source tool or virtual lab or programming language to implement modern encryption algorithms, hashing techniques and digital signature algorithms.*	**8-10**
	Modern encryption algorithms (symmetric and asymmetric algorithms), hashing techniques and digital signature algorithms. **Laboratory Exercises: (Suggested Tasks):** Comparison of DES and AES encryption performance in different modes of operation, implement and analyze RSA public-key cryptosystem for encryption and digital signatures, perform Diffie-Hellman key exchange, test message integrity using MD-5 and SHA-1 for varying message sizes, and evaluate the efficiency and security of hashing protocols. ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Compare the performance of DES and AES in different modes of operation using online tools or virtual lab and implement RSA digital signature scheme, Diffie-Hellman key exchange, and MD-5 and SHA-1 hash functions using Java or Python. (PI: 2.1.2, 2.2.5, 3.2.2, 3.4.2, 5.1.1)* *LO 2.2: Test and verify the integrity of messages using MD-5 and SHA-1 by generating hash values for different message sizes, comparing them to detect any modifications, (PI: 4.1.1, 4.3.1, 5.2.2, 11.1.1, 11.2.2)*	

03.	***Learning Objective/s:*** *Expected to use different network reconnaissance tools like sniffers, port scanners and other related tools to gather information about networks domain registrars.*	**6-8**
	Network Reconnaissance, Packet Analysis, and Vulnerability Assessment.	
	Laboratory Exercises: (Suggested Tasks): Perform network reconnaissance using WHOIS, dig, traceroute, and nslookup; capture and analyze ICMP, TCP, and HTTP packets using Wireshark in promiscuous and non-promiscuous modes; install and configure Nmap and Nessus for host discovery, port scanning, OS fingerprinting, and vulnerability assessment.	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Demonstrate and ability to apply network reconnaissance tools or commands and packet analysis techniques to identify network structures and potential vulnerabilities. (PI: 2.1.2, 2.4.2, 3.2.2, 3.4.2, 7.1.1, 7.2.2)* *LO 3.2: Proficiently use security assessment tools to analyze network behavior and system vulnerabilities. (PI: 5.1.1, 5.2.2)*	
04.	***Learning Objectives:*** • *Expected to setup personal firewall or install IDS (e.g. SNORT) and study the logs.* • *Expected to simulate buffer overflow attack.* • *Expected to implement virus and antivirus .*	**6-8**
	Simulation of Cyberattacks and Security Countermeasures **Laboratory Exercises: (Suggested Tasks):** Configure a personal firewall using iptables in Linux to control incoming and outgoing network traffic based on security rules. Simulate a buffer overflow attack using Splint or Cppcheck to analyze and detect vulnerabilities in C/C++ code. Implement email security using the GPG tool in Linux/Windows to encrypt and decrypt email messages for secure communication. Demonstrate the concept of viruses and antivirus mechanisms by implementing a simple virus program and analyzing antivirus detection techniques. Simulate a Denial-of-Service (DoS) attack using Hping, Hping3, and other tools to analyze network flooding and its impact on system performance.	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Identify security vulnerabilities in a system, analyze potential threats, and implement preventive mechanisms such as firewalls, encryption, and antivirus techniques to enhance system security. (PI: 2.1.1, 2.2.3, 3.4.2, 5.1.1 11.2.2, 11,1.1)* *LO 4.2: Verify and test security implementations by analyzing vulnerabilities, simulating attacks, and assessing system defenses. (PI: 4.1.3, 4.3.2, 5.2.2, 7.1.1, 7.2.2)*	
	By end of the course student will learn how to protect systems by using encryption, security tools, and testing for weaknesses. It teaches them to find threats and apply security measures.	
	Total Hours	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.1	Evaluate problem statements and identifies objectives.
2.2.3	Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
2.4.2	Analyse and interpret the results using contemporary tools.
3.2.1	Able to explore design alternatives
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements .
3.4.2	Able to implement and integrate the modules.
3.4.3	Able to verify the functionalities and validate the design
4.1.3	Able to choose appropriate hardware/software tools to conduct the experiment.
4.3.2	Critically analyse data for trends and correlations, stating possible errors and limitations.
5.1.1	Identify modern engineering tools such as computer aided drafting, modeling and analysis; techniques and resources for engineering activities
5.2.2	Demonstrate proficiency in using discipline-specific tools.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
11.1.1	Describe the rationale for the requirement for continuing professional development
11.2.1	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

Course Outcomes: A learner will be able to

1. Apply the knowledge of symmetric cryptography to implement classical ciphers. (LO 1.1, LO 1.2,)
2. Implement and analyze public key cryptosystem, hashing techniques and digital signature algorithm while continuously adapting to evolving encryption methods. (LO 2.1, LO 2.2)
3. Implement and evaluate system security measures using tools and techniques while continuously updating knowledge on emerging security threats and defense techniques. (LO 3.1, LO 3.2)
4. Simulate and mitigate various types of attacks using appropriate tools and techniques while continuously adapting to new attack vectors and counter measures. (LO 4.1, LO 4.2)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELBC608.1	-	3	3	3	3	-		-		-	-
CELBC608.2	-	3	3	3	3	-	3	-		-	3
CELBC608.3	-	3	3	-	3	-	3	-		-	3
CELBC608.4	-	3	3	-	3	-	3	-		-	3
Average	-	3	3	-	3	-	3	-		-	3

Text Books :

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. Practical Packet Analysis Using Wireshark to Solve Real-World Network Problems, Chris Sanders, Second Edition,2007, No Starch Press

Reference Books:

1. Atul Kahate, *"Cryptography and Network Security",* Tata McGraw-Hill Education, 2003.
2. Eric Cole, *"Network Security Bible",* Second Edition, Wiley, 2011
3. Computer Networks: A Systems Approach, Larry L.Peterson, Bruce S.Davie, , Second Edition, 2011, The Morgan Kaufmann Series in Networking

Other Resources:

1. https://www.wireshark.org/download.html
2. https://nmap.org/
3. https://www.tenable.com/products/nessus
4. https://cse29-iiith.vlabs.ac.in/
5. https://www.onlinecryptographytools.com/
6. https://www.cryptool.org/en/cto/

TERM WORK (25 Marks)

Suggested breakup of distribution

Lab Experiments: 10 Marks

Internal Assessment: Mid Practical examination: 10 marks

Attendance: 5 marks

END SEMESTER ASSESSMENT (Practical /Oral Examination) (25 Marks)

Practical performance: 15 Marks

Oral performance: 10 Marks

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
LBC	CELBC609	IOT & CLOUD COMPUTING LABORATORY	01

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total Marks**
25	**25**	**50**

Pre-requisite:

1. CEPCC408 Computer Network

Program Outcomes addressed:

1. PO1: Engineering knowledge:
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO4: Conduct investigations of complex problems
5. PO5: Engineering Tool Usage
6. PO11: Life-long learning

Course Objectives:

1. To guide students in deploying IoT devices to collect and transmit data.
2. To assist students in exploring various cloud computing service models and implement them to solve the given problems.
3. To lead students toward connecting IoT devices to cloud platforms for data storing and visualization.
4. To direct students in analysing and visualizing IoT data using cloud-based tools.

Module	Details	Hrs.
	Course Introduction This course emphasizes the practical implementation of designing and managing IoT systems integrated with cloud platforms, focusing on handling large data volumes for real-time monitoring and decision-making in IoT applications.	**01**
01.	**Introduction of IOT (Arduino/Raspberry Pi)** ***Learning Objective:*** *Learners will be able to design, implement, and manage IoT systems using (Arduino/Raspberry Pi), gaining practical skills in sensor integration, data collection and communication protocols.*	**6-8**
	Contents: Introduction to IoT and development of basic IoT systems using Arduino and Raspberry pi including setup and configuration, Integrating various sensors/ actuators and displaying the output.	

	Laboratory Exercises (Suggested Task): Setup the environment, develop basic IoT system on a given problem statement which integrates sensors like temperature sensor/ultrasonic sensor, actuators like LED/ servo motor and display output on the serial monitor/ LCD display. ***Self-Learning Topics: Self-Learning Topics: Linux command, SSH(Secure shell), Git and PWM signal*** ***Learning Outcomes:*** *A learner will be able to* *LO1. Design and Develop an IoT system to read data from sensors, analyze the output on the actuators and Identify the factors affecting its accuracy. (P.I.- 2.2.2, 3.4.2, 3.4.3, 5.1.2, 2.4.2, 5.3.1)*	
02.	**Introduction of Cloud Computing** ***Learning Objective:*** *Learners will be able to identify and comprehend with various service models such as IaaS, SaaS, PaaS and Database as a Service and Deploy and configure these cloud service models on cloud platforms.* **Contents:** Introduction to virtualization, Cloud Computing and AWS services. Basics of Docker and running docker on cloud. **Laboratory Exercises (Suggested Tasks):** Design and develop a cloud applications on a given problem statement by implementing services like EC2, Beanstalk, IAM, containerizing instances using ECS and using virtualization techniques. ***Self-Learning Topics: VPC, Migration*** ***Learning Outcomes:*** *A learner will be able to* *LO 2. Design and Develop a cloud application by implementing techniques like virtualization, containerization and using AWS services like EC2, IAM, Beanstalk, ECS, etc. (P.I.- 1.3.1, 5.1.2, 3.2.1, 5.1.1, 3.4.2, 1.4.1)*	**7-9**
03.	**Storing data from IoT device on Cloud.** ***Learning Objective:*** *To storing IoT data using cloud services.* **Contents:** Basics of Cloud storage and databases. Integration of IoT systems with cloud storage. **Laboratory Exercises (Suggested Tasks)**: Design and develop a cloud integrated IoT system for a given problem statement by using AWS storage services such as RDS, S3, EBS. ***Self-Learning Topics:*** ***Learning Outcomes:*** *A learner will be able to* *LO 3: Design and Develop a Cloud-integrated IoT system to integrate IoT sensors to cloud databases with security. (P.I.- 1.1.1, 5.1.1, 11.3.1, 1.3.1, 5.2.1, 11.2.2)*	**5-7**

04.	**Analyzing of Data using IOT and Cloud**	**7-9**
	Learning Objectives: *To store and analyze IoT data using cloud services.*	
	Contents: Data processing and analysis on cloud. Visualization and dashboards using cloud. **Laboratory Exercises (Suggested Tasks):** Develop cloud analytics system based on a given problem statement which analyzes real-time data from IoT system and generates reports for the user.	
	Self-Learning Topics: *Analysis tools*	
	Learning Outcomes: *A learner will be able to* *LO 4: Design and Develop a cloud analytics application which analyzes sensor data and generates user report in the form of visualizations to monitor IoT systems..(P.I.- 4.3.1, 5.1.1, 11.3.2, 4.3.4, 5.3.2, 11.2.2)*	
	Course Conclusion *The course conclusion will emphasize the learner's ability to implement, analyze and manage IoT systems integrated with cloud platforms. The learner will gain practical skills in handling large data volumes, ensuring real-time data processing, and enabling informed decision-making. By the end, the learner will be equipped to build secure, and efficient IoT solutions for various applications using cloud.*	
		Total **30**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem
2.2.2	Identify functionalities and computing resources.
2.4.2	Analyze and interpret the results using contemporary tools.
3.2.1	Able to explore design alternatives.
3.4.2	Able to implement and integrate the modules.
3.4.3	Able to verify the functionalities and validate the design.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
5.3.1	Discuss limitations and validate tools, techniques and resources
5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their us
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
11.3.1	Source and comprehend technical literature and other credible sources of information
11.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Design and analyse IoT systems that integrate various sensors, actuators, microcontrollers. (*LO 1*)
2. Analyze and implement various Cloud Computing service models (IaaS, PaaS, SaaS) to design and develop solutions for given real-world problems. (*LO 2)*
3. Integrate IoT applications on cloud services, enabling scalable data processing, storage, and real-time analytics using cloud-based solutions. (*LO 3*)
4. Visualize and analyze IoT-generated data using cloud-based tools, extracting meaningful insights and making data-driven decisions for IoT applications. (*LO 4*)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELC610.1	-	3	3	-	3	-	-	-	-	-	-
CELC610.2	3	-	3	-	3	-	-	-	-	-	-
CELC610.3	3	-	-	-	3	-	-	-	-	-	3
CELC610.4	-	-	-	3	3	-	-	-	-	-	3
Average	3	3	3	3	3	-	-	-	-	-	3

Text Books :

1. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014.
2. Hakima Chaouchi, “The Internet of Things - Connecting Objects to the Web”, 1st Edition, Wiley, 2010.
3. Francis daCosta,, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1 st Edition, Apress Publications, 2013. 4. Cuno Pfister,” Getting Started with the Internet of Things”, O’Reilly Media, 2011, ISBN: 978-1- 4493-9357-1.
4. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture".
5. Ricardo Puttini, Thomas Erl, Zaigham Mahmood, “Cloud Computing: Concepts, Technology & Architecture”, 1 st Edition, 2013, Prentice Hall International.
6. K. Chandrasekaran,“Essentials of Cloud Computing”, 1 st Edition, 2015, CRC Press Talyor & Francis.

Reference Books :

1. Borko Furht, Armando Escalante, “Handbook of Cloud Computing”,1 st Edition, 2010, Springer US.
2. Rajkumar Buyya, Christian Vecchiola , S.Thamarai Selvi, “Mastering Cloud Computing Foundations and Applications Programming”,1st Edition, 2013, Morgan Kaufmann.

Other Resources :

1. https://www.udemy.com/course/aws certified-solutions-architect
2. https://www.coursera.org/learn/aws-cloud-technical-essentials

IN-SEMESTER ASSESSMENT (25 MARKS)

Continuous Assessment - Theory-(15 Marks)

Suggested breakup of distribution

Practical Exercises- 10 Marks

Practical Test – 10 Marks

Regularity and Active Participation - 5 Marks.

END SEMESTER EXAMINATION (25 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Students will be assessed based on three parameters:

- Concept/ knowledge of IOT devices and Cloud Services
- Practical knowledge of IOT integration with Cloud
- Oral

Students will be randomly allocated a program from the list of laboratory exercises and will be asked to write appropriate Steps for the same. The Process steps is checked by the examiners (Internal and External) and weightage for this is 10 Marks.

Course Type	Course Code	Course Name	Credits
SBL	CESBL603	FULL STACK DEVELOPMENT LABORATORY	02

Examination Scheme		
Continuous Assessment	**End Semester Examination (ESE)**	**Total**
50	50	100

Pre-requisite:

1. ESL205 - Programming Laboratory-II (Java)
2. CESBL301 - Python Programming Laboratory
3. CESBL402 - Web Development Laboratory

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Engineering tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO9: Communication
8. PO 11: Life-long learning

Course Objectives:

1. To foster a deep understanding of UI/UX design principles and their application in creating user- centered web experiences.
2. To assist in developing proficiency in frontend development using React.js, including state management, routing, and component-based architecture.
3. To equip students to build robust and scalable backend applications using Node.js, Express.js, and MongoDB, mastering API design, data modeling, and advanced query techniques within the NoSQL paradigm.
4. To direct students to System design practices and cybersecurity practices.

Module	Detailed Contents	Hrs.
	Course Introduction This course introduces the MERN stack, a popular JavaScript-based technology stack for building modern web applications. Students will learn the fundamental concepts and practical skills required to develop full-stack web applications using MongoDB, Express.js, React.js, and Node.js, with a strong emphasis on user interface (UI) and user experience (UX) design principles.	**01**
01.	**Introduction to UI/UX Design** ***Learning Objective:***	**14-16**

	Learners will be able to foster a deep understanding of UI/UX design principles and their application in creating user-centered web experiences. **Content:** Introduction to UI/UX Design: Principles of User Experience (UX) and User Interface (UI), Design Thinking Process: Empathize, Define, Ideate, Prototype, Test User Research Methods: User Interviews, Surveys, User Personas, Introduction to wire framing tools (Figma /Adobe XD), Creating low-fidelity and high- fidelity prototypes, User Testing and Iterative Design ,WCAG guidelines, designing for users with disabilities Responsive Design Principles: Designing for different screen sizes and devices	
	Laboratory Exercises: (Suggested Tasks): Design UI/UX for given problem statement. (Study any existing applications) and design wireframes and low- fidelity prototypes for the same. – Test the usability of your prototypes with a small group of users and gather feedback – Produce a comprehensive report on the accessibility issues and proposed fixes on created app.	
	Self-Learning Topics: *-* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Demonstrate an ability to identify UI/UX principles and design intuitive interfaces, create wireframes, low- fidelity prototypes using tools like Figma or Adobe XD for a given problem (P.I : 2.1.1,2.1.2,3.2.1,3.2.2,5.1.1,5.3.2)* *LO 1.2: Perform usability testing by collecting and analyzing user feedback to enhance usability, and effectively document and present insights using structured formats. (P.I-4.1.1,4.3.4,9.1.2,9.1.3)*	
02.	**Frontend Development with React NextJS** ***Learning Objective****: Learners will be able to focus on mastering Next.js features like SSR, SSG, and routing while gaining hands-on experience in project setup, data fetching, and incremental static regeneration. Students will learn to build optimized, scalable web applications using modern Next.js practices.* **Content:** Introduction to React, Study of Next.js framework, Setting Up a Next.js Project, Routing in Next.js, Server-Side Rendering (SSR),Static Site Generation (SSG)	**12-14**
	Laboratory Exercises: (Suggested Tasks): Design a simple web pages for a given problem statement and display the product details, images, and allows users to add items to their cart using Next.js. – Add a simple "About Us" page and link to it from the homepage using the `next/link` component in existing web pages. – Add a dynamic blog post page that displays the full content of a specific blog post. (**Requirements:** Use `getServerSideProps()` to fetch the specific blog post data based on the URL slug.)	

	Learning Outcomes: *A learner will be able to* *LO 2.1: Demonstrate the ability to design and implement responsive dynamic web pages using Next.js for a given problem statement with required details (P.I: 2.1.1,2.2.4,3.2.2,5.1.1,5.2.2)* *LO 2.2 : Refine the architecture by incorporating efficient client-side navigation using next/link, server-side data fetching with getServerSideProps and enhancing rendering performance with SSR for dynamic blog posts (P.I : 3.4.1,4.3.1,4.3.2)*	
03.	**Backend Development with Node.js, Express and MongoDB** ***Learning Objective:*** *Learners will be able to build RESTful APIs with Node.js, Express, and MongoDB, focusing on authentication, data management, and performance optimization. Gain hands-on experience deploying secure and scalable backend applications*	**14-16**
	Content: Core concepts, modules, events, streams, building a Server with Express.js: Handling HTTP requests (GET, POST, PUT, DELETE), Middleware: Body parsing, logging, authentication, RESTful API Design: Principles of REST, designing API endpoints, connecting to MongoDB, CRUD operations with Mongoose, Schema Design: Defining data models, relationships. Implementing user authentication (e.g., JWT), authorization mechanisms (roles, permissions) , Error Handling and Validation: Handling API errors, input validation	
	Laboratory Exercises: (Suggested Tasks): Develop a RESTful API for given problem statement using Node.js and Express.js by adding features like user registration, login, content posting, following users, and retrieving user feeds. – Additionally, create a Node.js application that integrates with a MongoDB database to manage user data and perform CRUD operations for user profiles and preferences in given problem statement.	

	Learning Outcomes: *A learner will be able to* *LO 3.1: Integrate RESTful API principles and implement them using Node.js and Express.js. Refine the existing API design by incorporating additional features and enhancing its functionality based on the given problem statement. (P.I: 2.1.1,3.2.1, 2.3.2,3.4.1,5.2.2,)* *LO 3.2: Integrate Node.js with MongoDB using Mongoose, execute queries, implement secure authentication and authorization, and ensure data integrity through input validation and sanitization. (P.I:5.1.1,6.1.1,6.2.1)*	
04.	**Best practices (System design, Cybersecurity)** ***Learning Objective:*** *Learners will be able to apply system design principles, including microservices architecture, load balancing, caching, and scalability, while implementing cybersecurity best practices to secure web applications through HTTPS, authentication and authorization (OAuth, JWT), and mitigation of common vulnerabilities.*	**14-16**

	Content: System Design Principles: Micro services architecture, load balancing, caching, scalability, Cybersecurity Best Practices: Securing web applications (HTTPS), authentication and authorization (OAuth, JWT), preventing common vulnerabilities.	
	Laboratory Exercises: Design and develop a full-stack web application to solve a real-world problem, incorporating UI/UX design, frontend and backend development, database management, and deployment. Utilize micro services architecture with load balancing and caching for scalability. Implement security best practices, including HTTPS, authentication and authorization, and protection against common vulnerabilities. Provide system design, security measures, and architectural decisions with justifications.	
	Learning Outcomes: *A learner will be able to* *LO 4.1:Design, develop, and evaluate scalable, secure full-stack web applications using micro services architecture, integrating UI/UX, frontend, backend, database management, and deployment while ensuring authentication, data integrity, security best practices, and adherence to ethical and professional standards.(P.I:3.3.1,3.4.2,5.1.1,5.2.1,6.1.1,6.2.1, 7.1.1,7.2.2,11.1.1,11.2.2)*	
	Course Conclusion: By end of the course student will gain expertise in developing scalable, secure full-stack web applications by integrating UI/UX design, micro services architecture, and cybersecurity best practices. They will also enhance their ability to optimize performance and document system design effectively.	**01**
		Total **60**

Performance Indicators

PI No.	**P.I. Statement**
2.1.1	Evaluate problem statements and identifies objectives
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.2.4	Compare and contrast alternative solution/methods to select the best methods.
2.3.2	Identify design constraints for required performance criteria.
3.2.1	Able to explore design alternatives.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirement.
3.3.1	Able to perform systematic evaluation of the degree to which several design concepts meet the criteria.
3.4.1	Able to refine architecture design into a detailed design within the existing constraints.
3.4.2	Able to implement and integrate the modules.
4.1.1	Define a problem for purposes of investigation, its scope and importance
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
4.3.2	Critically analyze data for trends and correlations, stating possible errors and limitations
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions

5.1.1 Identify modern engineering tools, techniques and resources for engineering activities

5.2.1 Create/adapt/modify/extend tools and techniques to solve engineering problems

5.2.2 Demonstrate proficiency in using discipline-specific tools.

5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

6.1.1 Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level

6.2.1 Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

7.1.1 Identify situations of unethical professional conduct and propose ethical alternatives

7.2.2 Examine and apply moral & ethical principles to known case studies

9.1.2 Produce clear, well-constructed, and well-supported written engineering documents

9.1.3 Create flow in a document or presentation - a logical progression of ideas so that the main point is clear

11.1.1 Describe the rationale for the requirement for continuing professional development

11.2.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field

Course Outcomes: A learner will be able to-

1. Develop a strong understanding of user-centered design principles and apply them to create effective and user-friendly interfaces. (*LO 1.1, LO 1.2)*
2. Design an application using Next.js framework, including component-based architecture, state management, and advanced techniques like routing and server-side rendering. (*LO 2.1, LO 2.2)*
3. Create robust and scalable backend applications using Node.js and Express.js, integrating with databases and implementing secure APIs. (*LO 3.1, LO 3.2)*
4. Adapt best practices for building secure, scalable, and maintainable web applications. (*LO 4.1)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CESBL603.1	-	3	3	3	3	-	-	-	3	-	-
CESBL603.2	-	3	3	3	3	-	-	-	-	-	-
CESBL603.3	-	3	3	-	3	3	-	-	-	-	-
CESBL603.4	-	-	3	-	3	3	3	-	-	-	3
Average	-	**3**	**3**	**3**	**3**	**3**	**3**	-	**3**	-	**3**

Text Books:

1. Joel Marsh, “UX for Beginners”, O’Reilly , 2022
2. Next.js Cookbook: Learn how to build scalable and high-performance apps from scratch
3. *Pro Git* by Scott Chacon and Ben Straub

Reference Books:

1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, “Designing Interface” 3 rd Edition , O’Reilly 2020
2. Git Pocket Guide by Richard E. Silverman, O'Reilly Media 2013 ISBN: 978-1449325862

Other Resources:

1. https://www.interaction-design.org/literature

CONTINUOUS ASSESSMENT (50 Marks)

Laboratory Exercises: 15 Marks

Internal Assessment: 10 Marks

Regularity and active participation: 05 Marks

Practical Test: 20 Marks

Two practical tests will be conducted based on laboratory exercises.

1. Students will be randomly assigned two or more web development tasks to evaluate their web development skills.

2. Students will have a designated 2-hour time frame for code development/task execution. After the first hour, an internal examiner will assess the progress of each student' and provide feedback for enhancements, focusing on evaluating web development skills. Alongside web development skills, problem-solving abilities will also be evaluated.

3. Towards the end of the practical or during assessment, students will be asked questions to gauge their conceptual understanding of web development principles and techniques.

END SEMESTER EXAMINATION (Practical/Oral Examination) (50 Marks)

For the End semester exams, practical examination will be conducted. The details of the end- semester evaluation are as follows. It will consist of three sections:

Section 1: Practical Examination (35 Marks)

This section will have practical exam based on the laboratory exercises conducted during the term. The assessment criteria will be similar to Internal Practical Test. Each laboratory exercise can focus on different aspects of Full stack development such as UI/UX, Front end development, Backend development such as Node js , Express and MongoDB.

Section 2: Documentation and Presentation (05 Marks)

During the practical exam, students should incorporate comprehensive code comments for project

organization and readability. Additionally, they should demonstrate visually engaging and responsive user interfaces, prioritizing accessibility considerations.

Section 3: Oral (10 Marks)

Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
MNP	CEMNP604	Mini Project 2B	02 each

Course Objectives

1.To guide students in identifying societal or research needs and formulating them into problem statements.
2. To facilitate problem-solving in group settings.
3. To apply basic engineering principles to address identified problems.
4. To foster self-learning and research skills.

Course Outcomes

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

1. Identify problems based on societal or research needs and methodology for solving them.
2. Apply knowledge and skills to solve societal problems collaboratively.
3. Develop interpersonal skills necessary for teamwork.
4. Analyze, verify, and validate results effectively through various methodologies, including, test cases/benchmark data/theoretical/inferences/experiments/simulations, etc.
5. Evaluate the societal and environmental impacts of proposed solutions.
6. Adhere to standard engineering practices.
7. Excel in written and oral communication by technical report writing, oral presentation, and publishing results in

- Research/white paper/article/blog writing/publication, etc.
- Business plan for entrepreneurship product creation
- Patent filing/copyright.

8. Gain technical competencies by participating in competitions, hackathons, etc.
9. Demonstrate lifelong learning capabilities through self-directed group projects.
10. Apply project management principles effectively.

Guidelines for the Mini Project

- 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 etc.
- Students must form groups of 3 to 4 members either from the same or from different departments.
- Groups should conduct surveys to identify needs and develop problem statements in consultation with faculty.
- An implementation plan in Gantt/PERT/CPM chart format covering weekly activities must be submitted.
- Each group must maintain a logbook to record weekly progress, to be verified by the faculty supervisor.
- Faculty input should emphasize guiding by faculty and self-learning by group members.

- Groups should propose multiple solutions, select the best one in consultation with the supervisor, and develop a working model.
- The solution to be validated with proper justification and report to be compiled in standard format of the Institute. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.
- 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.
- 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.

In-Semester Continuous Assessment and End-Semester Examination Guidelines

- Continuous Assessment marks distribution in semester VI (50 marks):
  - 15 marks for the In-Semester Two Presentations
  - 05 marks for Participation in Project Competitions, TPP, etc.
  - 25 marks for the Final Report & Presentation
  - 05 marks for regularity and active participation

The review/progress monitoring committee will assess projects based on the following criteria.

Semester VI:

- Expected tasks include procuring components/systems, constructing a working prototype, and validating results based on prior semester work.
- Reviews will be conducted as follows:
  - The first review will assess the readiness to build a working prototype.
  - The second review will involve a poster presentation and demonstration of the working model in the last month of the semester.

In addition to above mentioned points, the following performance criteria shall be included during in-semester continuous assessment:

1. Quality of survey and need identification.
2. Clarity and innovativeness in problem definition and solutions.
3. Requirement gathering via SRS/feasibility study, cost-effectiveness, and societal impact of proposed solutions.
4. Completeness and full functioning of the working model.
5. Effective use of skill sets and engineering norms.
6. Verification & validation of the solutions/test cases.
7. Individual contributions to the group.
8. Clarity in written and oral communication.
9. Participation in technical paper presentation/project competitions/hackathon competitions, etc.

End-Semester Examination in Semester VI (50 marks):

1. Presentation and demonstration to internal and external examiners: 20 marks.
2. Emphasis on problem clarity, innovativeness, societal impact, functioning of the model, skill utilization, and communication clarity: 30 marks.

Course Type	Course Code	Course Name	Credits
ELC	ELC601	RESEARCH METHODOLOGY	02

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
50	--	--	--	--	50

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO6: The Engineer & The World.
4. PO7: Ethics
5. PO8: Individual & team work
6. PO9: Communication
7. PO11: Life-long learning

Course Objectives:

1. To gain the knowledge of use research tools and techniques to design research projects and form the hypothesis.
2. To familiarize students about the literature review practice for identifying the research gap.
3. To gain the knowledge about collection of data and qualitative/ quantitative analysis of data and results
4. To understand the key practices in preparation of a research report / paper.
5. To foster ethical practices in research and publications

Module	Details	Hrs
00	**Course Introduction:** This course aims to introduce students to the important aspects of research. The course is intended to make students aware of formal research and to overcome common misconceptions in research that may be present in their minds. At the end of this course, students shall be able to take up research activities in a more systematic and formal manner right from the beginning. This course on Research Methodology learned through experiential learning mechanism can play a significant and holistic role in contributing to the personal and professional development of students.	**1**
1	**Fundamentals of Research Methodology**	**4-5**
	Content: Types of Research, Research approaches, Empirical research methods, Significance of research, Research design, Case study method, Sampling technique, Sources of data, Selection of research problem, Research Ethics and Empiricism	

	Exercise: A group discussion on what is research and ethics in research with related case studies shall be conducted.	
2	**Formulation of a Research Problem & Hypothesis formulation**	**4-5**
	Content: Selection and formulation of a research problem, Objectives of formulation, Criteria of a good research problem, Literature Review Process and Formulation of Research Questions Hypothesis-Characteristics and Hypothesis Testing –Logic and Importance *Exercise: Groups of students shall make Technical Presentations on Selection of a research problem and Hypothesis formulations based on topics given.*	
3	**Research Design**	**4-5**
	Content: The Research framework, Research design: Need, Characteristics & Components; Experimental and non-experimental designs, Experimental and non-experimental hypothesis testing. Classification schemes for research design, Principles of experimental designs, Writing rationale for a research *Exercise: Students shall prepare the framework of research methods and techniques to conduct a study on a given real life case study covering key elements of the module.*	
4	**Sampling Method**	**3-4**
	Content: Probability or random sampling, Cluster sampling, Area sampling, Multi-stage sub-sampling, Random sampling with probability proportional to size, Non-probability sampling. *Exercise: A real life case study shall be demonstrated to students covering key elements of the module shall be covered.*	
5	**Data Collection & Data Analysis**	**4-5**
	Content: Sources of data, Collection of data, Measurement and scaling technique, Collection of data from appropriate sources (primary and secondary), Correlation and causation, Classification of quantitative analysis. Selection and analysis of multi-variate methods, Performing data analysis and presentation of results, Case study method. *Exercise: Group of students shall carry out exercise of real life data collection on a given research problem and data analysis and submit the report*	

6	**Report Writing and Journal Publication**	**3-4**
	Content: Preparation of a research report, Formats and Contents of report: Literature review, Presentation of research work, Research Design & Analysis, Results, Findings, and Contribution, Significance of research, and Conclusion. Mechanics of writing papers in Peer-reviewed Journals / Reputed Conferences. Ethics in Publication. *Exercise: Students shall prepare & submit a paper (4-5 pages) in a standard format (suitable universally accepted journal publication format) based on the exercises / research case study carried out in this course.*	
7	***Course Conclusion***	**1**
	Total	**30**

Course Outcome: Learner will be able to

CO1: Identify and demonstrate the importance of research process in science and technology domains

CO2: Perform literature reviews using print and online databases.

CO3: Analyse the data using qualitative and quantitative methods

CO4: Identify and prepare the key elements of a research report/ paper

CO5: Illustrate the rationale for research and publication ethics

Text Books:

1. C. R. Kothari and Gaurav Garg, Research Methodology: Methods and Techniques, New Age International Publisher, 2014.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, Sage Publication, 2018
3. R. Pannershelvam, Research Methodology, Prentice Hall, India, 2014

Reference Books:

1. John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Ed., SAGE, 2018.Geoffrey R. Marczyk, David DeMatteo & David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2005.
2. Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006.
3. Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006.
4. Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007.
5. Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006

Other Resources:

NPTEL Course: Research Methodology By Prof. Edamana Prasad, Prof. Prathap Haridoss (IIT Madras) Weblink https://onlinecourses.nptel.ac.in/noc25_ge28/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6011	ART OF LIVING	02

Program Outcomes addressed:

1. PO6 : The Engineer & The World
2. PO7 : Ethics
3. PO8 : Individual and Team Work
4. PO9: Communication
5. PO11: Life-long learning

Course Objectives :

1. To provide a comprehensive understanding of the principles of the Art of Living and their relevance to holistic well-being.
2. To equip participants with practical techniques like Sudarshan Kriya, yoga, and mindfulness for stress management and emotional balance
3. To enable participants to apply the Art of Living principles to enhance relationships, productivity, and life purpose.

Module	Details
01.	**Introduction to the Art of Living** Understanding the Mind and Stress, Breath and Life Energy, Basics of Yoga and Guided Meditation
02.	**Sudarshan Kriya and Breathing Techniques** Introduction to Sudarshan Kriya, Practicing Rhythmic Breathing Techniques
03.	**Emotional Well-being** Understanding and Balancing Emotions, Forgiveness and Gratitude Practices, Guided Meditation for Emotional Healing
04.	**Relationships and Social Connections** Compassion and Effective Communication, Stress-free Relationships, Group Activities for Trust and Collaboration
05.	**Living with Purpose and Awareness** Discovering Life Purpose, Mindfulness Practices, Time Management and Productivity
06.	**Sustaining the Practices** Developing a Daily Routine, Advanced Breathing Techniques, Reflections, and Closing Meditation
Total no. of hours: **30**	

Course Outcomes :

1. Gain insights into managing stress and emotions through breathwork and meditation
2. Develop skills for building harmonious relationships and enhancing emotional intelligence.
3. Cultivate mindfulness, compassion, and clarity in daily life.
4. Sustain the Art of Living practices for long-term well-being and self-discovery.

Text Books :

1. "Celebrating Silence" by Sri Sri Ravi Shankar (1999, Sri Sri Publications Trust)
2. "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar (1995, Inner Traditions International)
3. "The Miracle of Mindfulness" by Thich Nhat Hanh (1975, Beacon Press)

Reference Books :

1. "Wisdom for the New Millennium" by Sri Sri Ravi Shankar (2000, Sri Sri Publications Trust)
2. "The Healing Power of the Breath" by Richard P. Brown and Patricia L. Gerbarg (2012, Shambhala Publications)

Course Type	Course Code	Course Name	Credits
LLC	LLC6012	YOGA AND MEDITATION	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To raise awareness of the therapeutic and preventive benefits of Yoga and Meditation
2. To nurture Holistic wellness through the harmony of body, mind and self
3. To advocate for the application of Yogic science in the treatment and prevention of psychosomatic and Lifestyle disorders.
4. To inspire the practice of Yogic Science tools for fostering health and well-being in daily life.
5. To promote the art of purposeful and mindful living by cultivating a deep sense of oneness with the self, nature and the world.

MODULE	DETAILS
1.	**Introduction to Yoga and Meditation** Definition of Yoga, Importance of Yoga for Human life, Literature of Yoga: Yoga Sutra, Bhagavat Gita – Synthesis of Yoga, Hathapradipika etc. Challenges of health in students & youth - Studies, Yogic concept of Health and Meditation, Concept of Body and Disease in Yoga, Dimensions of Health- Physical, Mental, Social and Spiritual, Different types of yoga (Karma, Gyaan, Ashtanga, Bhakti), Eight limbs of ashtanga yoga.
2.	**Yoga and Wellness** Yoga and Medical perspectives – Health related fitness, Yoga for common ailments, Scientific Researches in Yoga, Yogic anatomy of Human body, Asanas – Definitions and classifications, Scientific reasoning behind the asanas, Yoga for Stress, Technostress and Lifestyle management. Mental Disturbances and Preventive, Curative Aspect of Yoga for Mental wellness.

3.	**Essentials of Yoga Practices** Difference between Yoga and Exercise, Obstacles in the path of Yogic Practices, Disciplines in Yogic practices – Prayers, Yama, Niyama, Place, Time, Diet, Schedule, Sequence for Yogic Practices. Yogasanas: Surya Namaskara, Standing asanas and Sitting asanas, Different groups of Yogasanas – Relaxation, Meditative, Digestive etc. Psycho-physiological effects and health benefits of Yogasana, Function and effect of Asanas - Digestive system, Respiratory system, Excretory system, Circulatory system, Nervous system etc.
4.	**Meditation – Role of Breath and Pranayama** Yogic anatomy, Wellness and Triguna system, Science of Pranayama – 'Prana', the vital principle, Prana and air element, Awareness - Breath Awareness, Different types of Breathing, Breath Control, Breath and Postures, Rhythmic Breathing, Pranic body in the five-fold body (Panchakosha), Power of breath, Difference between Pranayama and breathing, Prana and nervous system, Fivefold function of prana, Benefits of pranayama
5.	**Fundamental aspects of Meditation** Pranayama and deep breathing - Concept of Inhalation (Puraka), Retention (Kumbhaka), & Exhalation (Rechaka); Important Pranayamas; Pranayama and Meditation; Mind and Meditation; Inner Instrument – Mind, Constituents of Mind - Mana, Buddhi, Ahankar and Chitta(Consciousness), Magnitude of Mind, Buddhi – the determinative faculty; Body-Mind complex; Mind Cleansing; Yogic Meditation and Mindfulness meditations; Yogic Process and Outcome of Meditation – Pratyahara, Dharana and Dhyana; Scientific studies on Meditation and Healing.
6.	**Meditation Tools and Techniques** Why Meditate - States of Mind, Mind over Body – Processing Thoughts, Preparing for Meditation – Posture, Shanti prayers, Pranayama, Training the Mind: Practicing tools- Bhramari Pranayama, Sacred Pranav (Om) mantra, Mantra Japa/ajapa, Types of Mindfulness Meditations, Yoga Nidra, Body scan meditation, etc. Benefits of Meditation

Course Outcomes:

1. Gain comprehensive insights about the necessity of yoga for daily life.
2. Obtain a simplified understanding of the impact of mindful breathing on health wellbeing.
3. Acquire knowledge of 'practice and principles' of simple awareness meditation for Mental wellness
4. Gain required knowledge to improve overall health and immune system
5. Practice simple asanas and meditation techniques to improve concentration, self- confidence and inner peace

Text Books:

1. Light on the Yoga Sutras of Patanjali by B.K. Iyengar (Publisher: Orient Longman Pvt. Ltd. Mumbai)
2. Pranayama - The Art & Science by Dr. Nagendra H R (Publisher: Swami Vivekananda Yoga Prakashan, Bangalore)
3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Recommended Books

1. Pranayama-Science of Breath by Gharote, M. (Publisher: The Lonavla Yoga Institute, India)
2. Svatmarama's HathaYogaPradeepika by Gyan Shankar Sahay (Publisher: Yogic Heritage, India)
3. Yoga for Health and Peace by Padamshree Sadashiv Nimbalkar (Publisher: Yoga Vidya Niketan, Mumbai)

Other Resources:

1. NPTEL Course: Yoga and Positive Psychology for Managing career and life by Prof. Ashish Pandey, IIT Bombay.
Weblink https://archive.nptel.ac.in/courses/110/101/110101165/

2. SWAYAM Course: Yoga for Concentration by By Dr H R Nagendra, Dr Manjunath N K and Dr Apar Avinash Saoji from Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore.
Weblink: https://onlinecourses.swayam2.ac.in/aic23_ge05/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6013	HEALTH AND WELLNESS	02

Program Outcomes addressed:

1. PO6: The Engineer and The World
2. PO7: Ethics
3. PO11: Life-Long Learning

Course Objectives:

1. To advocate for the significance of Holistic wellness
2. To enhance all dimensions of wellness through the lens of scientific temper.
3. To foster integrative medicine through mindful lifestyle choices and guided practices
4. To promote the integration of scientific research with ancient wellness practices & techniques.

MODULE	DETAILS
1.	**Foundations of Health Well-being** Defining Health and Wellness, Dimensions of wellness Determinants of Health behavior, Health in everyday life Constitution of your body, Medical Anatomy of physical body Layers of your Body: Physical, Physiological, Psyche Yogic anatomy of Physiological and Psyche layers, Triguna system
2.	**Physical Wellbeing** Management of Ailments: Common, Acute, chronic Integrative medicines: Ayurveda, Naturopathy, Yoga etc. Preventive care for illness, Lifestyle, Dietary habits, Repair and Rejuvenation
3.	**Emotional Wellness** Types of Emotions, Symptoms of emotional wellness Studies on challenges of emotional wellness: Sleep, Stress, Resilience, eating habits, attention deficit, Digital fatigue, Communications etc. Emotions and physical wellness Understanding the trinity of senses, sense objects and emotions, Studies on breath regulation, Role of breath in emotions, Yogic methods to emotional wellness

4.	**Mental Wellness** What is Mental Wellness, Dimensions of mental Wellness Scientific studies on Mental disorder issues: Depression, anxiety, behavioural disorder, addiction, self-disconnection, suicidal thoughts etc. Mind-Body issues: Mental Wellness, Mental illness and Physical illness, Constitution of Mind – Manas, Buddhi, ahankara, Chitta, Consciousness Intelligence and Mental Wellness, Modifications of Mind Paths to Mental Wellness: Regulating Thoughts, Meditation tools and process - Pranayama, Pratyahara, Dharna, Dhyana, Mindfulness meditation, Chakra meditation, Sabdh(mantra) Meditation, spiritual engagements
5.	**Intellectual Wellness** Mind, Intelligence and Intellectual Wellness Aspects of Intellect, incapacitate Intellect, Examining Intellectual Wellness, Nurturing Intellectual Wellness
6.	**Spiritual Wellness** Yogic understanding of term 'spiritual' Relationship: Physical, Physiological, Psyche, Consciousness (Spiritual) Symptoms of spiritual wellness Studies on Spiritual wellness and Body Healing Practices for spiritual wellness: Prayers, Yoga and Meditation, spiritual engagements

Course Outcome: Learner will be able to

1. Gain a comprehensive understanding of Holistic Health
2. Acquire essential knowledge to regulate thoughts and behavior.
3. Apply holistic health tools for emotional stability and healthy mind
4. Develop proficiency in applying cognitive faculty for intellectual pursuits
5. Acquire holistic wisdom for attaining inner peace in daily life

Text Books

1. Nature Cure for All: Natural Remedies for Health Disorders (Publisher: Nisargopachar Gramsudhar Trust, Pune)

2. Towards the Wellness of Body, Mind and Self – Conference Proceedings Editor - Dr. Jayanti Chavan (Publisher: Institute of Science and Religion, Navi Mumbai)

3. Ayurveda & Panchakarma – The Science of Healing and Rejuvenation by Dr. Sunil V. Joshi (Publisher: Motilal Banarsidass Publishing House, Delhi)

Reference books

1. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health (Publisher: SVYP, Bangalore)

2. Text book of Kriya Yoga – The Cosmic Engineering of Life in the light of Medical Science by Yogacharyya Dr. Chanchal Roy Devsharmman
(Publisher: Motilal Banarsidass Publishing House, Delhi)

3. Yog – Its Philosophy and Practice by Swami Ramdev (Publisher: Divya Prakashan, Haridwar)

Other Resources:

1. NPTEL Course: Adolescent Health And Well-Being: A Holistic Approach by Dr. Sumana Samanta, Dr. Parmeshwar Satpathy, IIT Kharagpur.
Weblink https://nptel.ac.in/courses/127105236

2. NPTEL Course: The Science of Happiness and Wellbeing by By Prof. Priyadarshi Patnaik, Prof. Manas K. Mandal from IIT Kharagpur.
Weblink https://onlinecourses.nptel.ac.in/noc23_hs06/preview

Course Type	Course Code	Course Name	Credits
LLC	LLC6014	DIET AND NUTRITION	02

Program Outcomes addressed:

1. PO6 : The Engineer & Society
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To provide students with a comprehensive understanding of nutrition principles and their application in promoting optimal health.
2. To develop critical thinking skills to evaluate nutritional information and make informed decisions.
3. To apply knowledge of nutrition education and counselling to promote healthy nutrition practices in individuals and group.
4. To demonstrate an understanding of role of nutrition in disease prevention and management.

Module	Details
01.	**Nutrition for wellness -1** Introduction to nutrition, food pyramid, Macros: Carbohydrates, Protein and fats, Micros: Vitamins A C E K and D, Minerals-Calcium, Iron and Zinc Importance of hydration, signs and symptoms, stages of dehydration.
02.	**Nutrition wellness -2** Introduction to mindful eating, plate concept, understanding physical and emotional hunger, eating disorder-Anorexia nervosa, bulimia nervosa and binge eating.
03.	**Exercise and fitness** Introduction to exercise and its importance, types of exercise its classification, side effects of over exercising, Impact of sedentary lifestyle on body composition.
04.	**Sleep and relaxation** Flow of circadian rhythm, sleep cycle, stages of sleep, sides effects, sleeping disorder- sleep apnea, insomnia, sleep hygiene routine and foods inducing sleep
05.	**Managing stress** Introduction to stress, causes, effects of stress, management of stress, foods and adaptogenic foods for stress management.
06.	**The lifestyle flow** Morning/ wake up rituals, meal flow i.e in which order to eat, post meal flow, bedtime rituals – how should your last hour of the day look like
Total no. of hours: **30**	

Course Outcomes :

1. Understand the fundamentals of nutrition and its role in promoting wellness.
2. Apply mindful eating practices to manage physical and emotional hunger.
3. Assess the importance of exercise and its impact on health and fitness
4. Gain insights into sleep hygiene and manage sleep-related disorders.
5. Develop strategies for stress management using nutrition and adaptogenic foods.
6. Assess the importance of exercise and its impact on health and fitness

Text Books :

1. Nutrition and dietetics by C.S. shah: covers various aspects of nutrition, including nutrient metabolism, dietary planning and diet therapy.
2. Dietetics by B. Srilakshmi- covers aspects of dietetics including nutrition, food science and diet therapy.

Reference Books :

1. Nutrition science by B. Shrilakshmi: provides an overview of nutrition, nutrient metabolism and dietary patterns
2. Food science by B. Shrilakshmi covers food, including food composition, food processing and fo safety.

Course Type	Course Code	Course Name	Credits
LLC	LLC6015	PERSONALITY DEVELOPMENT	02

Program Outcomes addressed:

1. PO6 : The Engineer & Society
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To enhance self-awareness and self-confidence in the students.
2. To develop effective communication, leadership, and interpersonal skills.
3. To equip students with stress management and time management techniques.
4. To foster teamwork, problem-solving, and decision-making abilities.
5. To prepare students for professional life through resume building, interview skills, and networking.
6. To instill a growth mindset and adaptability in personal and professional contexts.

Module	Details
01.	**Self-Awareness and Emotional Intelligence** Understanding personality traits and self-assessment, Importance of emotional intelligence (EI) in personal and professional success, Strategies to enhance EI and self-awareness.
02.	**Communication Skills** Fundamentals of verbal and non-verbal communication, Public speaking, presentation skills, and storytelling, Listening skills and constructive feedback.
03.	**Leadership and Teamwork** Understanding importance of self-confidence, leadership styles, and their applications, Building effective teams and managing conflicts, Developing collaboration and networking skills.
04.	**Stress and Time Management** Recognizing stressors and managing stress effectively, Prioritization and goal-setting techniques, Tools for efficient time management and productivity.
05.	**Professional Development** Importance of presentation skills, resume writing, cover letter, and LinkedIn optimization, Interview preparation: Mock interviews and common questions, Networking skills and professional etiquette
06.	**Personal Growth and Adaptability** Developing a growth mindset and embracing lifelong learning, Cultivating resilience and adaptability to change, Setting long-term personal and professional goals
Total no. of hours: **30**	

Course Outcomes : By the end of this course, students will be able to:

1. Demonstrate increased self-awareness and emotional intelligence.
2. Communicate effectively in professional and personal contexts.
3. Exhibit leadership and teamwork skills in various scenarios.
4. Manage time and stress efficiently to enhance productivity.
5. Prepare a professional resume, excel in interviews, and network effectively.
6. Develop resilience, adaptability, and a growth-oriented mind-set.

Text Books :

1. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ / What Makes a Leader: Why Emotional Intelligence Matters
2. Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change

Reference Books :

1. Dale Carnegie, How to Win Friends and Influence People.
2. Anthony Robbins, Awaken the Giant Within: How to Take Immediate Control of Your Mental, Emotional, Physical, and Financial Destiny!
3. David J. Schwartz, The Magic of Thinking Big.
4. Robin Sharma, The Monk who sold his Ferrari.
5. Dorie Clark, Reinventing You: Define Your Brand, Imagine Your Future.
6. Gangadhar Joshi, Campus to Corporate: Your Roadmap to Employability.

Other Resources :

1. Videos and TED Talks by Simon Sinek, Brené Brown, Malcolm Gladwell and other motivational speakers
2. Online courses on communication and leadership (e.g., Coursera, LinkedIn Learning, EdX).