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.

&

Final Year Syllabus

Prepared by: Board of Studies for Computer Engineering

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

Effective from :2026-27

N- 2024

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-curricular activities, 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 continuous professional 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
IndianKnowledge 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	4	–	--	4	–	–	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	**15**	**12**	**–**	**15**	**6**	**–**	**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 Durationfor Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC101	Engineering Mathematics-I	20	30	50	1.5	2	100
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	**335**	**120**	**295**	**–**	**–**	**750**

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

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	4	–	--	4	–	–	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	**14**	**16**	**--**	**14**	**8**	**–**	**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)	ExamDuration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
BSC204	Engineering Mathematics-II	20	30	50	1.5	2	100
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	EngineeringGraphics 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	**390**	**90**	**295**	--	--	**775**

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

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 Durationfor 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 Syllabusfor 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 Durationfor 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 Syllabusfor 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 Communicationand 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 Durationfor 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 Syllabusfor 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	Data Science 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 Durationfor Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
CEPCC611	Cryptographyand 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	Data Science 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 Syllabusfor 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	Advanced Security 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	Digital Business Management
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 Durationfor 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	Advanced Security Laboratory	25	–	25	–	–	50
CEMJP701	Major Project-A	50	–	–	–	–	50
HSS703	Financial Planning	50	–	–	–	–	50
	Total	**230**	**120**	**250**	**–**	**–**	**600**

$ Please refer to the Syllabusfor 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	Disaster Management and Mitigation Measures
OEC8029	Environmental Management

Examination Scheme – B. Tech Semester-VIII

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Durationfor 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 Durationfor 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. FINAL YEAR SYLLABI

Course Type	Course Code	Course Name	Credits
PCC	CEPCC712	ARTIFICIAL 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. CEPCC302: Discrete Structures and Graph Theory
2. CEPCC303: Data Structures

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 5: Engineering Tool Usage
4. PO 6: The Engineer & The World
5. PO 7:Ethics
6. PO 9: Communication
7. PO 11: Life-long learning

Course Objectives:

1. To trace the evolution, components, foundations, and working principles of Artificial Intelligence and intelligent agents.
2. To acquaint with problem formulation techniques and implement search, heuristic, optimization, and planning strategies for intelligent decision-making.
3. To familiarize with knowledge representations using logic, ontologies, semantic networks, and apply reasoning under uncertainty.
4. To explore Generative AI, Explainable AI, and Responsible AI concepts focusing on fairness, ethics, privacy, and AI regulations..
5. To recognize AI applications across multiple domains and evaluate the role of AI in Industry 4.0, Industry 5.0, sustainability, and emerging AI trends.

Module	Details	Hrs
	Course Introduction Introduction, Intelligent behaviour, problem-solving nature, and role of AI in modern society. Conceptual understanding of intelligent agents, autonomy, and AI's impact on various domains.	**01**

01.	**Fundamentals of Artificial Intelligence and Agents**	**4-6**
	Learning Objective: *To trace the evolution and foundations of Artificial Intelligence, categorize intelligent systems and agents, interpret agent-environment interaction, and distinguish between traditional AI and Agentic AI based on autonomy, memory, tool-use, and goal orientation.*	
	Contents: Introduction, History of AI, Foundations of AI, Components of AI Categorization of Intelligent systems, Rationality , Agent environments, Types of Agents, Introduction to agentic AI, Agentic AI vs Traditional AI, Applications of AI in Modern Society	
	Self-Learning Topics: *Turing Test, Siri, Alexa, Tesla Autopilot, Google Lens, AutoGPT, Devin AI, LangChain Agents, Google Gemini Advanced.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1 Apply the categorization of intelligent systems to distinguish different types of AI-based solutions. (PI 1.3.1)* *LO 1.2 Apply foundational concepts of intelligent systems—including rationality, agent behavior, and environment types. (PI 1.4.1)* *LO 1.3 Classify agents as reactive, model-based, goal-based, utility-based, and learning agents. (PI 2.2.4)* *LO 1.4 Apply AI application frameworks to identify and analyze use-cases in healthcare, education, governance, finance, and agriculture. (PI 1.4.1, 6.1.1)* *LO 1.5 Compare Traditional AI and Agentic AI on autonomy, memory, tool usage, and goal orientation (PI 2.2.4, 11.2.2,11.3.1)* *LO 1.6 Identify types of agent environments(PI 2.1.2)*	
02.	**Problem Solving, Search and Optimization**	**8-10**
	Learning Objective: *To apply state-space-based problem formulations and implement uninformed, informed, optimization, and adversarial search strategies for intelligent decision-making..*	
	Contents: Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems, Problem Formulation, State-space Representation, Uninformed Search: BFS, DFS, IDS, Informed Search: Heuristic functions, Best-First, Greedy, A* Algorithm, Local Search algorithms and Optimization problems: Hill Climbing, Simulated Annealing, Genetic Algorithms, Adversarial Search: Minimax, Alpha-Beta Pruning.	
	Self-Learning Topics: *Bidirectional Search, Recursive Best-First Search (RBFS), Real-world applications of A**	

	Learning Outcomes: *A learner will be able to* *LO 2.1. Evaluate & Formulate problems. (PI 2.1.1)* *LO 2.2. Compare Uninformed Search strategies (BFS, DFS, IDS) to navigate problem spaces. (PI 2.2.4)* *LO 2.3. Apply heuristic-based Informed Search methods such as Greedy and A* to optimize solution paths. (PI 1.4.1)* *LO 2.4 Apply analytical reasoning to Local Search and Optimization techniques including Hill Climbing, Simulated Annealing, and Genetic Algorithms.(PI 1.3.1)* *LO 2.5. Apply adversarial search using Minimax and Alpha-Beta Pruning for strategic decision-making. (PI 1.3.1)*	
03.	**Knowledge Representation, Reasoning**	**8-10**
	Learning Objective: *To represent knowledge using propositional and predicate logic, apply reasoning mechanisms, and use structured knowledge representation techniques such as semantic networks, ontologies, and knowledge graphs.*	
	Contents: Introduction to Knowledge based agent, Knowledge Representation, Predicate Logic, Propositional Logic, Unification, Resolution, Forward and Backward Chaining, Semantic Networks, Ontologies, Knowledge Graphs, Semantic Web Concepts	
	Self-Learning Topics: *Knowledge Graphs in Google, LinkedIn, ChatGPT*	
	Learning Outcomes: *A learner will be able to* *LO 3.1. Apply propositional and predicate logic to represent knowledge.. (PI 1.3.1)* *LO 3.2. Apply unification and resolution for automated reasoning. (PI 1.4.1)* *LO 3.3. Use forward and backward chaining for knowledge inference. (PI 1.4.1)* *LO 3.4. Construct knowledge models using semantic networks, ontologies, and knowledge graphs. (PI 1.4.1)* *LO 3.5. Apply Semantic Web concepts to enhance intelligent information retrieval. (PI 1.4.1,2.2.3)* *LO 3.6 Compare Forward and Backward reasoning (PI 2.2.4)*	
04.	**Planning and Uncertainty**	**6-8**
	Learning Objectives: *To apply classical and advanced AI planning techniques, construct rule-based expert systems, and perform reasoning in uncertain domains using belief networks.*	
	Contents: Uncertain Knowledge and Reasoning: Uncertainty in real-world systems, Bayesian Networks, Inference Planning: State Space Planning, Hierarchical planning, Partial Order planning, Multiagent planning	

	Self-Learning Topics: *Google Maps as a Multi-Agent Planning System* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1. Apply uncertain knowledge representation using belief networks. (PI 1.4.1)* *LO 4.2. Perform simple inference in Bayesian belief networks for reasoning under uncertainty. (PI 1.1.2)* *LO 4.3. Apply state space, hierarchical, partial-order, and multi-agent planning strategies for goal-driven problem solving. (PI 1.4.1)*	
05.	**Generative AI, Explainable AI, Responsible AI & Ethics** ***Learning Objective/s:*** *To explore concepts of Generative AI, Large Language Models, Explainability techniques, and Responsible AI practices focusing on fairness, privacy, ethics, and AI regulations..* **Contents:** Generative AI, LLMs (ChatGPT, BERT Concept), Prompt Engineering, Explainable AI: SHAP, LIME, Responsible AI: Fairness, Bias, Privacy, AI Hallucinations, Ethical AI Practices, AI Regulations. ***Self-Learning Topics:*** *Deepfake Generation and Detection, OpenAI Responsible AI Guidelines, UNESCO Recommendation on AI Ethics.* ***Learning Outcomes :*** *A learner will be able to* *LO 5.1. Apply Generative AI concepts to analyze applications and large language models such as ChatGPT and BERT.(PI 1.4.1)* *LO 5.2. Use prompt engineering strategies to improve interaction with LLM-based AI systems. (PI 1.3.1, 5.1.1)* *LO 5.3. Apply Explainable AI techniques such as SHAP and LIME to interpret model decisions. (PI 5.2.1)* *LO 5.4. Identify Responsible AI principles including fairness, bias, privacy, and AI hallucinations. (PI 6.3.1,7.1.1)* *LO 5.5. Identify ethical AI practices and international AI regulatory frameworks. (PI 6.1.1,7.2.2)*	**7-9**
06.	**AI in Real-World Domains and Future Directions** ***Learning Objective/s:*** *To recognize the deployment of autonomous and agentic AI systems across real-world domains, assess their role in Industry 4.0 and Industry 5.0 ecosystems, and examine emerging trends including AI governance, safety, and sustainable development.* **Contents:** Autonomous AI Agents in industry and society, Multi-Agent Systems (MAS) in smart ecosystems, Tool-using AI agents (API calling, retrieval, workflow orchestration),Human-in-the-Loop vs Fully Autonomous Systems, AI Agents in Cybersecurity, Smart	**4-6**

	Manufacturing, Healthcare Monitoring, Autonomous Decision-Making Systems	
	Self-Learning Topics: *Cobots in Manufacturing, AI for SDGs (UNESCO), Quantum AI, Edge AI* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1. Identify autonomous AI applications in industry and society. (PI 6.1.1,9.1.1,9.3.1)* *LO 6.2. Assess the role of AI in Industry 4.0 and smart manufacturing ecosystems, including automation, IoT integration, and human–AI collaboration. (PI 6.2.1, 9.1.1,9.3.1)* *LO 6.3. Identify emerging AI paradigms such as multi-agent systems, Edge AI, quantum AI, and AI for Sustainable Development Goals (SDGs), and assess their future impact. (PI 11.2.1,11.2.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.2	Apply the concepts of probability, statistics and queuing theory in modelling of computer-based system, data and network protocols.
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 contrast alternative solution/methods to select the best methods
5.1.1	Identify modern engineering tools, techniques and resources for engineering Activities
5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
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
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity
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
9.1.1	Read, understand and interpret technical and non- technical information
9.3.1	Create engineering-standard figures,reports and drawings to complement writing and presentations

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

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

Course Outcomes: A learner will be able to -

1. Recognize AI foundations, intelligent agents, and real-world applications, and distinguish Traditional AI from Agentic AI.
   (LO 1.1,1.2,1.3,1.4,1.5)
2. Apply problem formulation and analyze search, heuristic, optimization, and adversarial strategies for intelligent problem solving. *(LO 2.1, 2.2, LO 2.3, LO 2.4, LO 2.5)*
3. Construct knowledge representations and apply logical, rule-based, and belief-network reasoning under certainty and uncertainty. *(LO3.1, LO 3.2, LO3.3, LO 3.4, LO 3.5, LO 4.3)*
4. Apply classical and multi-agent planning strategies and interpret the architecture.
   (LO 4.1, LO 4.2)
5. Examine Generative, Explainable, and Responsible AI, and evaluate AI's role in society, Industry 4.0/5.0, and future trends.
   (LO 5.1, LO 5.2, LO 5.3,LO 5.4, LO 5.5, LO 6.1, LO 6.2, LO 6.3)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPCC712.1	3	3	-	-	-	2	-	-	-	-	3
CEPCC712.2	3	3	-	-	-	-	-	-	-	-	-
CEPCC712.3	3	3	-	-	-	-	-	-	-	-	-
CEPCC712.4	3	-	-	-	-	-	-	-	-	-	-
CEPCC712.5	3	-	-	-	3	3	3	-	3	-	3
Average	3	3	-	-	3	3	3	-	3	-	3

Text Books :

1. Stuart Russell & Peter Norvig, *Artificial Intelligence – A Modern Approach*, Pearson.
2. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill.
3. Nils Nilsson, *Principles of Artificial Intelligence*, Narosa.
4. Molnar, C. (2025). Interpretable Machine Learning: A Guide for Making Black Box Models Explainable (3rd ed.)

Reference Books :

1. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education,2017
2. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education
3. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011

Other Resources :

1. NPTEL: Artificial Intelligence: Search Methods for Problem Solving By Prof. Deepak Khemani, IIT Madras https://nptel.ac.in/courses/106106226
2. NPTEL: An Introduction to Artificial Intelligence By Prof. Mausam, IIT Delhi, https://nptel.ac.in/courses/106102220

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

a. Assignment on live problems/ case studies: 10 Marks
b. Class test: 05 marks
c. 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	CEPEC7031	DEEP 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. CEPCC406- Analysis of Algorithm
2. CEPCC408- Computer Network

Program Outcomes addressed:

1. PO1 : Engineering knowledge
2. PO2 : Problem Analysis
3. PO3 : Design/Development of Solutions
4. PO5: Engineering Tool Usage
5. PO6 : The Engineer & The World
6. PO11: Life-long learning

Course Objectives:

1. To acquaint with the fundamentals of Neural Network.
2. To facilitate in depth understanding of training Deep Neural Networks.
3. To acquire knowledge of Convolution Neural Networks, Auto encoders and Recurrent Neural Networks.
4. To encourage in exploring emerging trends in Deep Learning to develop intelligent applications.

Module	Detailed Contents	Hrs.
	Course Introduction This course provides students with a comprehensive understanding of deep learning, focusing on both foundational concepts and advanced architectures. Students will gain hands-on and conceptual proficiency in key deep learning paradigms, including Convolutional Neural Networks (CNNs) for supervised learning, Auto encoders for unsupervised representation learning, and Recurrent Neural Networks (RNNs) for sequence modelling. The course also explores recent trends such as Generative Adversarial Networks (GANs), preparing	**01**

	students to apply deep learning methods to real-world, research-oriented, and industry-driven applications in an evolving AI landscape.	
01.	**Fundamentals of Neural Network** *Learning Objective:* *To explore the composition of biological neuron underlying the structure of deep neural network, key terminologies and historical evolution of deep learning.*	**4-6**
	Contents: • Fundamentals of Neural Network: Biological neuron • Mc-Culloch Pitts Neuron, Perceptron, Multilayer Perceptron • Perceptron Learning, Delta learning • Linearly separable, linearly non-separable classes • Deep Networks: Fundamentals, Brief History • Basic Terminologies of Deep Learning • Classes of Deep Learning	
	Self-Learning Topics: *Transfer Learning* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply linear-algebraic and discrete-mathematical techniques to model and interpret the mathematical representation of biological neurons and the McCulloch–Pitts neuron.(P.I.-1.1.1)* *LO 1.2: Apply principles of computer engineering to determine linear seperability of given dataset using perceptron-based model.(P.I - 1.4.1)* *LO 1.3: Apply foundational and specialized engineering concepts to classify core terminologies and major categories of Deep Learning models.(P.I.-1.3.1)*	
02.	**Training, Optimization and Regularization of Deep Neural Network** ***Learning Objective:*** *To construe the training of deep networks, analyze and apply appropriate learning parameters and optimization techniques, and evaluate and implement effective regularization strategies for improved model performance.*	**10-12**
	Contents: • Training Feedforward DNN: Multi Layered Feed Forward Neural Network, Learning Factors • Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU • Loss functions: Squared Error loss, Cross Entropy • Choosing output function and loss function • Optimization: Learning with backpropagation • Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp. • Regularization: Overview of Overfitting, Types of biases, Bias Variance Tradeoff.	

	• Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, adding noise to input and output.	
	Self-Learning Topics: *Advanced Regularization Techniques in Modern Deep Learning Architectures.* *Hyperparameter Tuning Strategies for Efficient Deep Learning Model Optimization.* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply linear-algebraic and discrete-mathematical techniques to mathematically represent Multi Layered Feed Forward Neural Network.(P.I.-1.1.1)* *LO 2.2: Apply engineering knowledge to formulate computational modules with suitable activation and loss functions for a given problem context.(P.I.-1.3.1)* *LO 2.3: Identify optimization algorithms of a computer based system and tune learning parameters by applying mathematical foundations of gradient-based methods to Enhance convergence and model performance.(P.I.- 2.1.2)* *LO 2.4: Compare and contrast alternative methods to select appropriate regularization technique to reduce over-fitting and improve model generalization using engineering fundamentals.(P.I.- 2.2.4)*	
03.	**Convolutional Neural Networks (CNN): Supervised Learning** ***Learning Objective:*** *To interpret supervised learning concepts in CNNs, apprehend convolution operations and architectural components, and interpret foundational models for effective feature extraction and classification.*	**7-9**
	Contents: • **Supervised Learning:** Convolution operation, Padding, Stride, Relation between input, output and filter size • CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN • Fully Connected NN vs CNN • Variants of basic Convolution function • LeNET: Architecture • AlexNET: Architecture	
	Self-Learning Topics: *Evolution of CNN Architectures: From VGG to ResNet* *Advanced CNN Architectures* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply fundamental knowledge of mathematics to compute convolution, padding and stride operations in CNNs. (P.I.- 1.1.1)* *LO 3.2: Apply theory and principles of supervised learning to determine the relationship between input, output, and filter size in CNNs.(P.I.- 1.3.1)* *LO3.3: Design a variety of potential CNN architecture design solutions suited for specified image data to meet functional requirements.(P.I.- 3.2.2)* *LO 3.4: Explore classical architectural designs for basic image-classification problems.(P.I.- 3.2.1)*	

04.	**Autoencoders: Unsupervised Learning** ***Learning Objective:*** *To construe the concepts of unsupervised learning and auto-encoder models for image processing tasks such as image compression and feature representation.*	**6-8**
	Contents: • Unsupervised Learning: Introduction • Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders • Autoencoders bottleneck and its impact. • Application of Auto-encoders: Image Compression.	
	Self-Learning Topics: *Variational Autoencoders (VAEs)* ***Learning Outcomes:*** *A learner will be able to* *LO 4.1: Apply fundamental knowledge of neural networks to interpret the working principles of autoencoder.(P.I.-1.3.1)* *LO 4.2: Apply foundational and specialized engineering concepts to categorize major autoencoder models.(P.I.-1.4.1)* *LO4.3: Explore a variety of potential auto-encoder variants for a given image compression or denoising pipeline.(P.I.-3.2.1)* *LO4.4: Able to verify the functionalities influencing representation capacity and reconstruction quality for different datasets and validate design of auto-*	
05	**Recurrent Neural Networks (RNN)** ***Learning Objective:*** *To construe the concepts of sequence learning that enhances usability of application .* **Contents:** • Sequence Learning Problem, Unfolding Computational graphs • Recurrent Neural Network, Bidirectional RNN • Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT • Long Short-Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit. ***Self-Learning Topics:*** *Attention Mechanisms in RNNs, RNNs in Reinforcement Learning* ***Learning Outcomes:*** *A learner will be able to* *LO 5.1: Apply fundamentals of engineering to solve sequencing learning problems.(PI.-1.3.1)* *LO 5.2: Apply computer engineering principles to construe with working principles of Recurrent Neural Networks.(PI.- 1.4.1)* *LO 5.3: Analyze and interpret the effect of vanishing and exploding gradient problems on learning performance in sequence modeling tasks.(PI.- 2.4.2)* *LO 5.4:Analyze sequence-learning problems to identify and conform suitable RNN variants and assess the strengths and limitations of relevant tools for their implementation.(PI.-2.1.2, 5.1.2, 5.2.1)* *LO 5.5: Interpret legislation and regulations relevant for the protection of the public and understand the relationship between the technical, socio-economic and environmental dimensions of sustainability while deploying RNN-based systems.(P.I.-6.2.1, 6.3.2)*	**7-9**

06.	**Emerging Trends** ***Learning Objective:*** *Utilize emerging trends that enhance usability of generative models .* **Contents:** • Generative Adversarial Network (GAN) Architecture • Image Generation and DeepFake ***Self-Learning Topics:*** *Advanced GAN Variants: StyleGAN, CycleGAN, and BigGAN.* *Responsible AI Practices for Generative Models* ***Learning Outcomes:*** *A learner will be able to* *LO 6.1: Apply engineering fundamentals to interpret GAN architecture and training dynamics.(P.I.-1.3.1)* *LO 6.2: Apply theory and principles of computer science and engineering to generate synthetic images with GAN architecture.(P.I.-1.4.1)* *LO 6.3: Recognize ethical, legal and societal implications and understand the environmental dimensions of sustainability for image generation using Deep Fake technique.(P.I.-6.2.1, 6.3.2)* *LO 6.4:Demonstrate continuous professional learning by tracking developments in generative models and analyzing sourced technical information for feasibility and sustainability to propose diverse applications.(P.I.-11.2.2, 11.3.2)*	**3-5**
	Course Conclusion: Upon completion of the Deep Learning course, students will acquire the proficiency to design, train, and apply advanced neural network models to solve real-world, research-oriented, and industry-focused 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.
2.1.2	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.
2.4.2	Analyze 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

requirement.

3.4.3 Able to verify the functionalities and validate the design.

5.1.2 Adapt the 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.

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

6.3.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability

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

Course Outcomes: A learner will be able to-

1. Apply engineering and mathematical foundations to interpret mathematical representation of biological neurons,differentiate linearly separable and linearly non-separable classes using perceptron-based methods, and categorize core terminologies and principal categories of deep learning models.*(LO 1.1, LO 1.2, LO 1.3)*
2. Formulate modules of a system with appropriate activation and loss functions for a given problem context, identify optimization algorithms to enhance model performance, and analyze alternative regularization techniques for more generalized model.*(LO 2.1, LO 2.2, LO 2.3, LO 2.4)*
3. Design variety of potential CNN architectures suited for specified image data and explore classical architectural designs- LeNet and AlexNet for image-classification problems.(LO 3.1, LO 3.2, LO 3.3, LO 3.4)
4. Design components of auto-encoder variants for image compression or denoising pipelines across different datasets.(LO 4.1, LO 4.2, LO 4.3, LO 4.4)
5. Apply engineering principles to solve sequence learning problems by adapting appropriate Recurrent Neural Network (RNN) variants and tools, while considering ethical, legal, and sustainability impacts on society and the environment.*(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5)*
6. Apply principles of computer science and engineering to evaluate Generative Adversarial Network (GAN) architectures for synthetic image generation,while continuously tracking emerging trends with consideration of ethical, legal, and sustainability impacts on society and the environment.(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
CEPEC7031.1	3	--	--	--	--	--	--	--	--	--	--
CEPEC7031.2	3	3	--	--	--	--	--	--	--	--	--
CEPEC7031.3	3	--	3	--	--	--	--	--	--	--	--
CEPEC7031.4	3	--	3	--	--	--	--	--	--	--	--
CEPEC7031.5	3	3	--	--	3	3	--	--	--	--	--
CEPEC7031.6	3	--	--	--	--	3	--	--	--	--	3
Average	3	3	3	--	3	3	--	--	--	--	3

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning, MIT Press Ltd, 2016
2. Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIt Press.

Reference Books:

1. Fundamentals of deep learning: Designing next-generation machine intelligence algorithms, Buduma, N. and Locascio, N.,2017, O'Reilly Media, Inc.
2. Deep learning with Python ,François Chollet,(Vol. 361). 2018 New York,Manning.
3. Deep Learning Cookbook, Douwe Osinga,O'REILLY, SPD Publishers, Delhi.
4. Neural Network- A Comprehensive Foundation,Simon Haykin, Prentice Hall International, Inc
5. Principles of soft computing,S.N.Sivanandam and S.N.Deepa, Wiley India

Other Resources:

1. https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184/
4. https://www.deeplearningbook.org

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

1. Assignment on live problems/case studies: 10 Marks

   (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.)

2. Article reading and summarization: 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	CEPEC7032	NATURAL LANGUAGE PROCESSING	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. CEPCC303-Data Structures
2. CEPCC509 -Theory of Computer Science
3. 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 Tools usage
6. PO8: Individual and Collaborative Team Work

Course Objectives:

1. To inculcate learners to the basic concepts, linguistic foundations, key processing stages, and real-world relevance of Natural Language Processing.
2. To familiarize text preprocessing, morphological analysis, and statistical word-level modeling in NLP.
3. To guide learners to leverage syntactic structures and sequence modeling using POS tagging, grammar, and neural models.
4. To facilitate the learners to apply semantic representation, word sense disambiguation, and embedding models for meaning extraction in NLP.
5. To instill discourse structure, reference resolution, and pragmatic aspects of language, and to explore evaluation techniques for NLP systems.
6. To equip the learners to apply NLP techniques to design real world NLP applications.

Module	Details	Hrs
	Course Introduction This course introduces the fundamental concepts and modern techniques of Natural Language Processing (NLP). It focuses on facilitating the learners to enable machines to process and understand human language for applications such as translation, summarization, and sentiment analysis, fostering skills essential for AI and data-driven language technologies.	**01**
01.	**Introduction to NLP** ***Learning Objective/s:*** *Learners are expected to explore the fundamental concepts of Natural Language Processing, focusing on its linguistic foundations, stages of processing, types of ambiguities, major challenges, and real-world applications.*	**03**
	Contents: 1.1 NLP Pipeline and Levels of Analysis: Stages in NLP processing-text preprocessing, morphological, syntactic, semantic, pragmatic, and application-level stages. 1.2 Ambiguity and Challenges in NLP (English and Indian Languages) 1.3 Applications of NLP 1.4 Tools and Resources: NLTK, SpaCy, Hugging Face	
	Self-Learning Topics: *NLP for Indian Languages, Unicode and Tokenizers, variety of tools for regional language preprocessing and data formats*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Apply fundamental mathematical and statistical concepts to understand the NLP pipeline. (P.I. – 1.1.1)* *LO 1.2: Apply core computer science principles to the different stages of NLP processing. (P.I. – 1.4.1)* *LO 1.3: Identify and describe the key modules of an NLP system, including preprocessing, morphological, syntactic, semantic, pragmatic, and application-level analysis. (P.I. – 2.1.2)* *LO 1.4: Analyze the limitations and challenges of NLP solutions, including ambiguity in English and Indian languages. (P.I. – 2.4.3)*	
02.	**Text Processing and Word-Level Analysis** ***Learning Objective/s:*** *To study the processes involved in text preprocessing, lexical and morphological analysis, and to understand the use of regular expressions, finite-state methods, and statistical models such as N-grams for word-level processing and representation in Natural Language Processing.*	**11**
	Contents: 2.1 Lexical Analysis: Basics of lexical processing and word representation. 2.2 Empirical Laws on Raw Text 2.3 Preprocessing tasks: Sentence segmentation, tokenization, normalization, stop-word removal, stemming, lemmatization 2.4 Morphological Analysis: Inflectional and derivational morphology	

	2.5 Regular Relations and Finite-State Morphology: Regular expressions, finite-state automata, and transducers for morphological analysis. 2.6 Stemming and Lemmatization: Porter and Snowball algorithms; dictionary- and rule-based lemmatization. 2.7 Statistical Models 2.7.1 N-gram Models: unigram, bigram, trigram, and their evaluation. 2.7.2 Smoothing Techniques: Laplace, Good–Turing 2.7.3 Evaluation Metrics: Perplexity 2.8 Word Representation Models: Bag of Words and TF-IDF features for statistical text representation.	
	Self-Learning Topics: *Edit Distance and Noisy Channel Models for text normalization and spelling correction*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply mathematical models to analyze lexical processing and word-level patterns. (P.I. – 1.1.1)* *LO 2.2: Apply core computer science principles to implement text analysis tasks such as tokenization, stemming, lemmatization, and morphological processing. (P.I. – 1.4.1)* *LO 2.3: Recognize and apply relevant mathematical and algorithmic techniques to analyze raw text and interpret linguistic patterns.(P.I. – 2.1.3)* *LO 2.4: Implement NLP algorithms using engineering mathematics, including finite-state automata and regular relations for morphological analysis. (P.I. – 2.4.1)* *LO 2.5: Define a clear and precise problem statement for lexical, preprocessing, or morphological text processing tasks, including appropriate objectives and scope. (P.I. – 3.1.1)* *LO 2.6: Design, compare, and evaluate multiple text preprocessing and feature extraction pipelines, including Bag-of-Words and TF-IDF representations. (P.I. – 3.2.2)*	
03.	**Syntax Analysis and Sequence Modeling** ***Learning Objective/s:*** *Expected to leverage syntactic structures and sequence modeling using POS tagging, grammar formalisms, and neural models to analyse and design efficient syntactic parsing and sequence labeling solutions in NLP.*	**10**
	Contents:	
	3.1 Part-of-Speech (POS) Tagging: Stochastic based approach; POS tagging using Hidden Markov Model (HMM) and Viterbi algorithm; challenges in POS tagging. 3.2 Discriminative Models for Sequence Labeling: Maximum Entropy Markov Model (MEMM) and Conditional Random Field (CRF),BiLSTM-CRF for neural sequence labeling. 3.3 Grammar Formalisms: Context-Free Grammar (CFG) and Probabilistic Context-Free Grammar (PCFG); modelling syntactic structure and constituency. 3.4 Parsing Techniques: 3.4.1 Top-Down Parsers: Predictive and Early Parser; 3.4.2 Bottom-Up Parsers: Shift-Reduce and CKY algorithm; 3.4.3 Introduction to Dependency and Constituency Parsing. 3.5 Neural Sequence Models: Introduction to Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU) models for syntactic sequence	

	processing; overview of Attention Mechanisms and Transformers for modern NLP parsing tasks.	
	Self-Learning Topics: *Transformer-based models (BERT, GPT) for sequence labeling and syntactic parsing.*	
	Learning Outcomes: *Learner should be able to* *LO 3.1: Apply mathematical and statistical concepts to model syntactic structures and sequence-labeling methods in NLP.(P.I. – 1.1.1)* *LO 3.2: Apply core computer science principles to model syntactic structures and sequence labeling tasks. (P.I. – 1.4.1)* *LO 3.3: Implement syntactic and sequence modeling solutions using mathematical and computational models such as HMMs, CRFs, and neural architectures. (P.I. – 2.4.1)* *LO 3.4: Identify the limitations and sources of errors in syntactic and sequence labeling solutions. (P.I. – 2.4.3)* *LO 3.5: Define a clear problem statement with appropriate objectives and scope for syntax-related NLP tasks. (P.I. – 3.1.1)* *LO 3.6: Design and evaluate alternative approaches for POS tagging, parsing, and sequence labeling tasks. (P.I. – 3.2.2)*	
04.	**Semantic Analysis and Word Representations** ***Learning Objective/s:*** *To understand semantic representation and lexical relations, apply word sense disambiguation techniques, and explore vector-based and contextual embedding models for capturing word meaning in NLP.*	**08**
	Contents:	
	4.1 Semantic Analysis: Meaning representation, lexical semantics, and relations among words: synonymy, polysemy, hyponymy, meronymy, and semantic ambiguity. 4.2 Word Sense Disambiguation (WSD): Approaches to WSD: knowledge-based (Lesk's Algorithm), supervised (Naïve Bayes), and unsupervised (clustering-based). (Classical Approaches,Intermediate / Machine Learning–Enhanced Approaches, Deep Learning–Based / Contextual WSD) 4.3 Vector Semantics and Word Embeddings: Vectorization techniques for representing meaning; distributional semantics and word embeddings: Word2Vec and GloVe; introduction to subword embeddings (FastText) and contextual embeddings (BERT).	
	Self-Learning Topics: *Transformer-based models (BERT, RoBERTa, GPT) for contextual and multilingual semantic representation.*	
	Learning Outcomes:	
	A learner will be able to *LO 4.1: Apply mathematical and statistical concepts to analyze semantic meaning, word relations, and word-sense patterns in NLP. (P.I. – 1.1.1)* *LO 4.2: Apply computer science and AI principles to understand semantic analysis and meaning representation. (P.I. – 1.4.1)* *LO 4.3: Implement semantic and word-sense models using appropriate mathematical formulations. (P.I. – 2.4.1)*	

	LO 4.4: Analyze the limitations of semantic models used in NLP. (P.I. – 2.4.3) *LO 4.5: Able to choose appropriate procedures, algorithms, and test cases for semantic analysis tasks.(P.I. – 4.1.2)* *LO 4.6:Interpret data-driven trends in Word Sense Disambiguation and word embedding techniques.(P.I. – 4.3.2)* *LO 4.7: Create tools or workflows for word embeddings and semantic modeling. (P.I. – 5.1.2)* *LO 4.8: Adapt modern NLP frameworks to implement and refine semantic and embedding-based models. (P.I. – 5.2.2)*	
05.	**Discourse and Advanced NLP** ***Learning Objective/s:*** *To understand discourse structure, reference and coreference resolution, and pragmatic aspects of language, and to explore modern neural approaches and evaluation metrics in NLP.*	**06**
	Contents: 5.1 Discourse Structure and Coherence: Discourse relations, cohesion and coherence in connected text; syntactic and semantic constraints on discourse interpretation. 5.2 Reference and Coreference Resolution: Reference phenomena and resolution techniques; anaphora resolution using Hobbs' Algorithm and Centering Theory; introduction to neural coreference models in NLP. 5.3 Pragmatics in NLP: Pragmatic aspects of language :implicature, presupposition, and speech acts in computational interpretation. 5.4 Evaluation Metrics in NLP: Evaluation of NLP systems using BLEU, ROUGE, and F1-score metrics.	
	Self-Learning Topics: *Transformer-based and neural models for coreference resolution and discourse understanding.*	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Apply mathematical techniques to analyze and evaluate discourse and coreference resolution methods. (P.I. – 1.1.1)* *LO 5.2: Apply theoretical principles of computer science and linguistic knowledge to analyze discourse structure and coherence.(P.I. – 1.4.1)* *LO 5.3 Apply algorithmic and engineering mathematics principles to implement discourse and coreference resolution techniques. (P.I. – 2.4.1)* *LO 5.4: Analyze evaluation metrics to assess NLP system performance. (P.I. – 2.4.3)* *LO 5.5: Choose appropriate algorithms and procedures for reference and coreference resolution tasks.(P.I. – 4.1.2)* *LO 5.6: Identify strengths, limitations, and trends revealed through metric-based evaluation.(P.I. – 4.3.2)*	
06.	**Applications and Ethical Perspectives in NLP** ***Learning Objective/s:*** *To study key NLP applications such as machine translation, summarization, sentiment analysis, and question answering, and to understand ethical considerations and challenges in low-resource language processing.*	**05**

	Contents: 6.1 Machine Translation: Rule-based, statistical, and neural approaches; introduction to transformer-based models. 6.2 Text Summarization: Extractive vs. abstractive summarization; evaluation metrics. 6.3 Sentiment Analysis: Lexicon-based and supervised learning approaches for opinion mining. 6.4 Information Extraction and Question Answering: Entity recognition, relation extraction, and retrieval-augmented generation (RAG) for QA systems. 6.5 Ethics and Societal Impact in NLP: Bias and fairness in models, privacy concerns, hallucinations, misinformation, and cultural inclusivity. 6.6 NLP for Low-Resource and Regional Languages: Challenges and tools for Indian and underrepresented languages.	
	Self-Learning Topics: *Conversational AI and multilingual NLP applications using transformer-based models.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply mathematical and statistical foundations to understand and analyze core components of complex NLP systems.(P.I. 1.1.1)* *LO 6.2: Apply principles of computer science and engineering to design and evaluate solutions for diverse NLP tasks.(P.I. 1.4.1)* *LO 6.3: Identify the key components and processing steps involved in advanced NLP applications to determine requirements for solving a given task.(P.I. -2.1.2)* *LO 6.4: Identify the limitations and potential sources of error in advanced NLP applications (P.I. -2.4.3)* *LO 6.5: Define a clear problem statement with appropriate objectives and scope for advanced NLP tasks. (P.I. -3.1.1)* *LO 6.6: Generate multiple design approaches to address functional requirements in NLP applications.(P.I. -3.2.2)* *LO 6.7: Create or adapt tools and techniques to address NLP problems. (P.I. -5.1.2)* *LO 6.8: Elaborate effective use of NLP tools and frameworks. (P.I. -5.2.2)* *LO 6.9: Demonstrate effective communication, collaborative problem-solving, and teamwork in NLP tasks.(P.I. -8.2.1)* *LO 6.10: Present integrated team results with clear coordination and contribution from all members.(P.I. -8.3.1)*	
	Course Conclusion This course offers an integrated understanding of linguistic theory and computational methods in Natural Language Processing, enabling students to apply classical and neural approaches to analyze and model language, and to develop responsible NLP solutions for real-world applications. It builds a strong foundation for advanced research and innovation in artificial intelligence and human language 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.
1.4.1	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.
2.1.3	Identify mathematical algorithmic knowledge that applies to a given problem.
2.4.1	Applies engineering mathematics to implement the solution.
2.4.3	Identify the limitations of the solution and sources/ causes.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
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 for trends, stating possible errors and limitations.
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, teamwork.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.

Course Outcomes: Learner will be able to-

1. Develop a basic understanding of Natural Language Processing with regards to knowledge, ambiguity, stages, challenges and applications in NLP for effective analysis of the NLP pipeline. (LO 1.1, LO 1.2, LO 1.3, LO 1.4)
2. Apply text preprocessing techniques, perform morphological analysis, and use statistical models for word-level language processing. (LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6)
3. Design and evaluate computational approaches for syntactic and sequence-labeling tasks in NLP. (LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6)
4. Develop strategies to model and analyze meaning in language using semantic relations, word-sense techniques, and embedding-based representations. (LO 4.1, LO 4.2, LO4.3, LO 4.4, LO 4.5, LO 4.6, LO 4.7, LO 4.8)
5. Apply discourse and pragmatic analysis using reference resolution techniques and evaluate NLP systems using standard metrics.(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)
6. Develop solutions for various NLP problems.(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, LO 6.6, LO 6.7, LO 6.8, LO 6.9, LO 6.10)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPE5012.1	3	3	-	-	-	-	-	-	-	-	-
CEPE5012.2	3	3	3	-	-	-	-	-	-	-	-
CEPE5012.3	3	3	3	-	-	-	-	-	-	-	-
CEPE5012.4	3	3	-	3	3	-	-	-	-	-	-
CEPE5012.5	3	3	-	3	-	-	-	-	-	-	-
CEPE5012.6	3	3	3	-	3	-	-	3	-	-	-
Average	3	3	3	3	3	-	-	3	-	-	-

Text Books:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

Reference Books:

1. Alexander Clark, Chris Fox, and Shalom Lappin, The Handbook of Computational Linguistics and Natural Language Processing, Wiley-Blackwell, 2010
2. Steven Bird, Ewan Klein, and Edward Loper, Natural Language Processing with Python (NLTK Book), O'Reilly Media, 2nd Edition, 2021
3. Jacob Eisenstein, Introduction to Natural Language Processing, MIT Press, 2019
4. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, and Harshit Surana, Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, O'Reilly Media, 2020

Other Resources:

1. https://www.coursera.org/specializations/natural-language-processing
2. http://www.cse.iitb.ac.in/~cs626-449
3. http://cse24-iiith.virtual-labs.ac.in/#
4. https://nptel.ac.in/courses/106105158

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

Assignment on Live problems / Case Studies wherein problem statements such as text classification, sentiment analysis, or part-of-speech tagging are given prior. Students are expected to research and collect relevant linguistic datasets and resources. They can use these resources and solve the assigned NLP problem on the specified date and time in Institute premises in the presence of a 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	CEPEC7033	UI/UX	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. CESBL402- Web Development Laboratory
2. CESBL603- Full Stack Development Laboratory

Program Outcomes addressed:

1. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design and Development of Solution
4. PO 4: Conduct investigation of Complex Problem
5. PO 5: Engineering Tool Usage
6. PO 8: Individual and Collaborative Team Work
7. PO 9: Communication
8. PO 11: Life-long learning

Course Objectives:

1. To establish a understanding of the Design Thinking process and the core principles of UI/UX design, highlighting their roles and importance in creating effective interfaces.
2. To equip students with the skills to plan, conduct, and analyze user research using industry-standard methods and tools, enabling them to define clear user requirements and create data-driven user personas.
3. To equip students with the skills to translate user journey concepts into a high-fidelity, interactive prototype by mastering visual design principles using modern tools.
4. To equip students with the skills to systematically create and iterate on wireframes at various levels of fidelity, and to develop functional prototypes for user testing and feedback.
5. To analyze and apply specialized UX principles for emerging technologies like AR/VR, VUI, and IoT, while critically evaluating the ethical responsibilities and accessibility requirements inherent in modern design practice.

Module	Details	Hrs.
	Course Introduction This course introduces the core principles and process of User Interface (UI) and User Experience (UX) Design. Students will explore user research, interaction design, and visual design principles using industry-standard tools like Figma. The curriculum equips you with the skills to prototype, test, and develop intuitive digital experiences in designing user interfaces.	**01**
01.	**Introduction to UI/UX** Learning Objective: T*o make the learner able to define Design Thinking and its five-stage process, and to differentiate between UI and UX by explaining their distinct roles in designing user interfaces.* **Contents:** Introduction to Design thinking, 5 stages of design thinking – Empathize, Define, Ideate, Prototype, Test; Definition of Design with respect to digital media, User Interface, User experience, Difference between UI and UX. History of UX. Need of UI and UX in creating User Interfaces. ***Self-Learning Topics:*** *Empathy & User Interview* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply the five-stage Design Thinking process (Empathize, Define, Ideate, Prototype, Test) to deconstruct a given user problem and define a human-centered problem statement. (P.I. 1.3.1)* *LO 1.2: Apply the core principles of User-Centered Design to differentiate between the distinct roles, components, and objectives of User Interface (UI) and User Experience (UX). (P.I. 1.4.1)* *LO 1.3: Identify the key developments and driving needs behind the field of UX to justify its critical importance in the development of successful interfaces. (P.I. 2.1.2)* *LO 1.4: Identify the appropriate stage of the Design Thinking process that applies to a given design activity, such as user research, prototyping, or usability testing. (P.I. 2.1.3)*	**5-7**
02.	**User Requirements and its Analysis** ***Learning Objective:*** *To select, integrate, and apply appropriate qualitative and quantitative research methods to systematically gather and analyze user data, to validated user requirements and detailed personas that effectively guide the design process.* **Contents:** Introduction to research and analysis tool (freeware) such as FigJam; User requirements – Definition; Types of user research, Qualitative research, Quantitative research. Tools to collect user requirements – personal observation, interviews, questionnaire, User/ Expert reviews; Understanding target audience and client requirements, Competitive analysis, Affinity mapping, Defining User Persona. Self-Learning Topics: FigJam for Collaborative Synthesis ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply engineering fundamentals to implement affinity mapping for identifying user patterns and define key user persona attributes to solve a user requirements problem. (P.I. 1.3.1)*	**7-9**

	LO 2.2: Apply qualitative and quantitative research methods to analyze user needs and client requirements, synthesizing data into defined user personas and design criteria. (P.I. 1.4.1). *LO 2.3: Compare and contrast qualitative and quantitative research methods to select appropriate data collection tools for gathering user requirements based on project constraints and information needs. (P.I. 2.2.4)* *LO 2.4: Arrive at validated user requirements through systematic analysis by applying user research principles to formulate comprehensive research plans that integrate multiple data collection methods. (P.I. 2.4.4)* *LO 2.5: Implement and integrate research synthesis methods, including affinity mapping and competitive analysis, to translate raw user data into actionable insights and user personas. (P.I. 3.4.2)* *LO 2.6: Explore design alternatives by evaluating research findings and market data to create detailed user personas; then develop and validate user requirements documentation that addresses both user needs and business objectives. (P.I. 3.2.1)*	
03.	**User Interface Design** ***Learning Objective**: To make learner to be able to apply core visual design principles and storytelling techniques to plan, design, and justify the creation of an effective and aesthetically coherent user interface using a standard design tool.* **Contents:** Storyboarding, User journey mapping; Gestalt principles of design - Aesthetics in UI design - Using Light, Color and Contrast Effectively in UI Design; Introduction to any freeware design tool such as Figma; Visual Communication Design - effective visual communication for graphical user interface ***Self-Learning Topics:** Gestalt Principles Analysis* ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply Gestalt principles and visual design fundamentals to create storyboards and user journey maps that effectively communicate interface layout and interaction flow for graphical user interfaces. (P.I. 1.3.1)* *LO 3.2: Explore and compare alternative design approaches for user interfaces to achieve specified aesthetic and goals. (P.I. 3.2.1)* *LO 3.3: Implement and integrate core UI components using standard design tools to demonstrate system viability and justify the selection of specific visual design. (P.I. 3.4.2)* *LO 3.4: Investigate and define the scope of a user experience problem by identifying stages of the design thinking process, then utilize modern design tools to create storyboards and user journey maps, while clearly communicating the rationale and explaining the importance of evolving design standards for effective visual communication in a team. (P.I. 2.1.3, 4.1.1, 5.1.1, 8.2.1, 9.1.1, 11.2.2)* *LO 3.5: Explore different design ideas to plan the creation of a visual interface, build it using adapted tools, document the feasible solution, and present the final integrated result as a team. (P.I. 3.2.1, 4.2.1, 5.1.2, 9.1.2, 11.3.2, 8.3.1)*	**7-9**
04.	**User Experience Design Tool** ***Learning Objectives:** To make learner to be able to design, prototype, and validate a cohesive and engaging user experience by applying interaction design principles and systematically utilizing a design system within a standard UX tool.* **Contents:** Introduction to User Experience design; UX design open source tool such as - Figma features – Navigations, interactions, Buttons Creating library; Gamification, micro-animation; Creating visual identity of the project – design system, design theme ***Self-Learning Topics:** Interactive Prototyping, Gamification Analysis*	**7-9**

	Learning Outcomes:	
	A learner will be able to *LO 4.1:Apply fundamental design principles to create navigations, interactions, and component libraries using modern tools, solving core user interface design problems. (P.I. 1.3.1)* *LO 4.2: Apply the theoretical principles of user-centered design to solve interaction problems by defining the functional scope of navigation systems, button libraries, and animated feedback loops. (P.I. 1.4.1)* *LO 4.3: Define and Investigate the problem of creating an engaging user experience by defining its scope and justifying the importance of interaction design. (P.I. 4.1.1)* *LO 4.4: Design and develop a procedural sequence of interactive components (including navigations, buttons, and micro-animations) to create a functional prototype for a given user task, justifying the design methodology. (P.I. 4.2.1)* *LO 4.5: Identify and select modern UX design tools and prototyping techniques to implement and explore alternative design solutions for interactive user experiences. (P.I. 5.1.1)* *LO 4.6: Create and adapt the use of a design system as a fundamental project tool to efficiently maintain visual consistency and implement complex interactive themes. (P.I. 5.1.2)*	
05.	**Prototyping and Testing** ***Learning Objective/s:*** *To make learner to be able to systematically explore, design, and develop a functional interactive prototype by creating wireframes at various fidelities, justifying design choices, and validating the solution through user testing.*	**7-9**
	Contents: Purpose of wireframing, Types – low fidelity, medium fidelity, high fidelity; Basics of sketching, Creating low fidelity wireframes, medium fidelity and high fidelity in Figma; Basic considerations in wireframing – device, size, behavior, interaction; Elements used in wireframing – visual design, high fidelity elements; Prototyping and Testing	
	Self-Learning Topics: *Wireframe Fidelity Comparison*	
	Learning Outcomes :	
	A learner will be able to *LO 5.1: Explore design alternatives for a user interface by evaluating different combinations of low, medium, and high-fidelity wireframes to meet varying project requirements for communication, feedback, and detail. (P.I. 3.2.1)* *LO 5.2: Evaluate, select, and justify a candidate wireframe fidelity for a given design stage, then implement and integrate the chosen wireframes into a prototype for further development. (P.I. 3.3.2)* *LO 5.3: Define a specific problem statement for a digital application, clearly articulating its scope and importance by analyzing the capabilities and limitations of standard wireframing and prototyping techniques. (P.I. 4.1.1)* *LO 5.4: Design and develop an appropriate procedural methodology for creating and testing wireframes and prototypes based on the defined objectives of a specific digital application. (P.I. 4.2.1)* *LO 5.5: Investigate the core problem of designing a user interface for a specified application by defining its scope and importance, exploring design alternatives through various wireframe fidelities, and identifying modern design tools for its development, while demonstrating effective team communication and problem-solving skills. (P.I. 3.2.1, 4.1.1, 5.1.1, 8.2.1)* *LO 5.6: Design and develop a functional interactive prototype by selecting and adapting appropriate methodologies and tools (e.g., Figma), implementing and integrating the*	

	chosen wireframe components into a cohesive system, and presenting the final results as a unified team. (P.I. 3.4.2, 4.2.1, 5.1.2, 8.3.1)	
06.	**Design for Emerging Technologies and Future Trends**	**5-7**
	Learning Objective/s: *To make **l**earner to be able to analyze, design, and evaluate user experiences for emerging technologies like AR/VR, VUI, and IoT by applying specialized UX principles and adhering to ethical frameworks of accessibility, inclusivity, and user privacy.*	
	Contents: UX Principles for AR/VR, Challenges in Designing Immersive Experiences, Voice User Interface (VUI) and Conversational Design; Designing for Smart Assistants, UI/UX for Wearables and IoT Devices; Design Ethics-Accessibility and Inclusivity in Design; Ethical Issues in UX: Dark Patterns, Privacy Concerns.	
	Self-Learning Topics: *AR/VR Usability Heuristics, VUI Conversation Flow Design*	
	Learning Outcomes:	
	A learner will be able to *LO 6.1: Apply engineering fundamentals to identify the inherent challenges of designing user experiences for immersive, voice-based, and wearable systems. (P.I. 1.3.1)* *LO 6.2: Apply theory and principles of computer science engineering to solve engineering problems related to usability constraints, accessibility requirements, and ethical frameworks in the design of AR/VR, VUI, and wearable systems. (P.I. 1.4.1)* *LO 6.3: Define the core UX challenges in immersive systems by investigating the conflicts between human perception and the technical constraints of AR/VR environments. (P.I. 4.1.1)* *LO 6.4: Design and develop testing methodologies to evaluate the usability and ethical implications of voice user interfaces and wearable device interactions for specific user contexts. (P.I. 4.2.1)* *LO 6.5: Analyze accessibility rules and ethical issues to find the right tools and methods for building inclusive designs. (P.I. 2.1.3, 5.1.1)* *LO 6.6: Explore design alternatives and adapt existing design patterns to create an accessible interface solution for a specific emerging technology context (e.g., AR/VR, VUI, or IoT). (P.I. 3.2.1, 5.1.2)*	
	Course Conclusion This course has provided a comprehensive journey through the foundational principles and advanced practices of User-Centered Design. Understanding the core philosophy of Design Thinking and mastering user research techniques to applying visual design principles and building interactive prototypes with industry-standard tools.	**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
2.1.2	Identifies processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.1.3	Identifies mathematical algorithmic knowledge (Stages of design thinking proces) that applies to a given problem
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.4.1	Applies engineering mathematics to implement the solution.

2.4.4 Arrive at conclusions with respect to the objectives.
3.2.1 Ability to explore design alternatives.
3.3.2 Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4.2 Able to implement and integrate the modules.
4.1.1 Define a problem for purposes of investigation, its scope and importance
4.2.1 Design and develop appropriate procedures/methodologies based on the study objectives
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
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 nontechnical 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 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes: A learner will be able to -

1. Apply the Design Thinking process and analyze core UI/UX principles to deconstruct user problems and determine the key stages for developing human-centered user interfaces. (LO 1.1, LO 1.2, LO 1.3, LO 1.4)
2. Analyze and compare user research methods to design a validated research plan and synthesize user data into defined personas and requirements for designing interfaces. (LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6)
3. Design and develop interactive user experiences by implementing appropriate visual design principles, prototyping techniques, and design systems to create functional and engaging digital interfaces in a team. (LO 3.1 to LO 3.5 and LO 4.1 to LO 4.6)
4. Implement a complete wireframing and prototyping pipeline using appropriate modern design tools to solve interaction design problems in digital applications. (LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6)
5. Design, implement, and evaluate accessible user experiences for emerging technologies by selecting appropriate design frameworks and testing methodologies to solve problems in usability and ethical compliances. (LO 6.1, to LO 6.6)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC7033.1	3	3	--	--	--	--	--	--	--	--	--
CEPEC7033.2	3	3	3	--	--	--	--	--	--	--	--
CEPEC7033.3	3	3	3	3	3	--	--	3	3	--	3
CEPEC7033.4	--	--	3	3	3	--	--	3	--	--	--
CEPEC7033.5	3	2	--	3	3	--	--	--	--	--	--
Average	3	3	3	3	3	--	--	3	3	--	3

Text Books:

1. Jesse James Garrett, "The Elements of User Experience: User-Centered Design for the Web and Beyond", New Riders Publishing, ISBN:978-0-321-68368-7.
2. Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef," Design Thinking: The Handbook", World Scientific Publishing Co Pte Ltd, ISBN-10: 9811203504, ISBN-13: 978-9811203503.
3. Fabio Staiano, "Designing and Prototyping Interfaces with Figma", Packt Publishing Ltd, ISBN-10: 180056418X ISBN-13: 978-1800564183
4. Kilian Langenfeld, "Design Thinking for Beginners", Personal Growth Hackers, ISBN-10: 3967160629 ISBN-13: 978-3967160628

Reference Books:

1. Norman, Donald A. The Design of Everyday Things. Revised and expanded edition. New York: Basic Books, 2013..
2. Maurya, R. K. (2018). Computer Graphics with Virtual Reality (3rd ed.). Wiley India
3. Johnson, Jeff. Designing with the Mind in Mind: A Simple Guide to Understanding User Interface Design Rules. 3rd ed. Cambridge, MA: Morgan Kaufmann, 2020.

Other Resources:

1. Complete UI/UX Design Course 2025: Figma+AI+Real Project, https://www.udemy.com/share/10dboB/
2. Complete Web & Mobile Designer: UI/UX, Figma, https://www.udemy.com/share/103F1h/
3. Intro to AR/VR/MR/XR: Technologies, Applications & Issues, Instructor: Michael Nebeling https://www.coursera.org/learn/intro-augmented-virtual-mixed-extended-reality-technologies-applications-issues
4. Wireframe, https://wireframe.cc/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested breakup of distribution

a) One MCQ Test as per GATE exam pattern / level: 05 Marks
b) Observation and active participation in class :05 Marks
c) Class Test: 05 Marks
d) Article reading with report writing: 05 Marks

3. 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	CEPEC7034	ADVANCE ALGORITHMS	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. CEPCC303- Data Structure
3. CEPCC405- Engineering Mathematics-IV
4. CEPCC408- Analysis of Algorithms

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. PO8: Individual and Collaborative Teamwork
8. PO9: Communication
9. PO11: Life-long learning

Course Objectives:

1. To strengthen the concepts of mathematical and probabilistic foundations essential for the design and analysis of advanced algorithms.
2. To facilitate the learners to develop the ability to design and analyze randomized and probabilistic algorithms.
3. To enable students to address computational intractability by exploring reduction techniques, approximation algorithms, parameterized complexity, and kernelization methods.
4. To impart knowledge of parallel and distributed algorithmic paradigms for achieving scalability, efficiency, and fault tolerance in large-scale and networked systems.
5. To introduce algorithmic principles grounded in game theory and strategic behaviour, enabling the analysis and design of computational systems.
6. To familiarize learners with emerging algorithmic paradigms, like quantum computing and hybrid quantum-classical algorithms, emphasizing their applications in optimization and cryptographic problems.

Module	Details	Hrs.
	Course Introduction: This course offers an in-depth understanding of advanced algorithmic techniques, including probabilistic, approximation, and parallel computing methods. It helps computer engineering students strengthen their problem-solving and analytical skills for designing efficient and scalable solutions. The knowledge gained is directly applicable to real-life domains such as cryptography, network optimization, distributed systems, artificial intelligence, and data-driven decision-making.	**01**
01.	**Mathematical Foundations for Advanced Algorithms** ***Learning Objectives:*** *Learners are expected to apply and demonstrate core mathematical concepts—such as algebra, number theory, probability, and graph theory*	
	Contents: 1.1 Number Theory and Algebra in Algorithms: Modular arithmetic, Chinese remainder theorem, Group/field-based algorithms, applications in cryptography 2.1 Probabilistic Methods: Linearity of expectation, Markov/Chebyshev inequalities, Derandomization techniques (method of conditional expectations) 3.1 Computational Graphs: Graph models of computation, Algebraic graph theory: adjacency/algebraic connectivity, Applications in network flows, reliability	
	Self-Learning Topics*: Fast-exponentiation, RSA key generation*	**5-7**
	Learning Outcomes: *A learner will be able to* *LO 1.1. Apply modular arithmetic and algebraic structures such as groups and fields to solve algorithmic problems in cryptography and number theory. (P.I.-1.1.1)* *LO 1.2. Apply theory and principles of Computer Engineering to solve problems based on computational graphs, algebraic connectivity, and graph-based models used in network algorithms. (P.I.-1.4.1)* *LO 1.3: Compare and contrast alternative strategies of probabilistic methods to select best methods (P.I. 2.2.4)* *LO 1.4 Identify the existing solution/methods to solve the computational problems using graph theory (P.I.-2.2.3)* *LO 1.5 Apply mathematical and Engineering tools such as modular arithmetic and graph-theoretic models, recognize societal and security implications of cryptographic algorithms, clearly document analytical results, and identify knowledge gaps for further independent learning. (P.I.- 1.1.1, 1.4.1, P.I.- 6.1.1, 6.3.1, P.I.- 9.2.1, P.I.- 9.2.2. P.I.-11.1.1, 11.1.2)*	
02.	**Randomization and Probabilistic Techniques:** ***Learning Objective/s:*** *Learners are expected to design and simulate randomization and probabilistic techniques in algorithm design and analysis.*	**7-9**

	Contents: 2.1 Randomized Algorithms: Las Vegas vs Monte Carlo algorithms, Applications in selection, hashing, primality testing, Monte Carlo Methods, Estimation algorithms, variance reduction 2.2 Markov Chains : Stationary distributions, convergence, mixing times Applications: Markov Chain Monte Carlo (MCMC) 2.3 Random Walks on Graphs: Cover time, hitting time, Applications in connectivity, network reliability	
	Self-Learning Topics: ***Coupling methods and mixing-time analysis***	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the concepts of probability using Markov Chain Monte Carlo (MCMC) methods for probabilistic sampling to solve Engineering problems (P.I. -1.3.1)* *LO 2.2: Apply theory and principles of computer science and engineering to solve an engineering problem based on random walks (P.I. -1.4.1)* LO 2.*3: Identify the mathematical or algorithmic concepts of randomized algorithms, Markov chains, random walks) applicable to solving a given computational problem. (PI 2.1.3)* *LO 2.4: Identify the algorithmic requirements of a complex computational problem and analyze appropriate randomized, Markov chain–based, or random-walk models to formulate a suitable solution strategy. (P.I. -2.1.3)* *LO 2.5 Analyze and interpret the results of randomized, MCMC, and random-walk-based algorithms, select appropriate procedures for investigation, work effectively in a team to solve the problem, and document the results in a clear technical report. (PI 2.4.2, P.I.- 4.3.1, P.I. - 4.3.3,* 8.1.1, 8.3.1, *P.I.- 9.2.1, P.I.- 9.2.2)*	
03.	**Complexity, Hardness, and Approximation** ***Learning Objective:*** *Learners are expected to analyze problem hardness, explore reductions, and design approximation algorithms for efficiently tackling intractable or optimization problems.*	**6-8**
	Contents: 3.1 Reducing Hardness: Reductions and completeness, PCP theorem intuition and hardness of approximation 3.2 Approximation Algorithms: Greedy, primal-dual, linear programming relaxation, Approximation ratios and hardness barriers 3.3 DNF Counting and Beyond: Complexity of counting problems (#P-hardness), Approximate counting methods (Markov Chain Monte Carlo for #SAT) 3.4 Kernelization: Parameterized complexity and FPT, Kernelization strategies for NP-hard problems	
	Self-Learning Topics: *Inapproximability results using the PCP theorem*	

	Learning Outcomes: *A learner will be able to* *LO 3.1: Use mathematical techniques—such as discrete structures, linear algebra, and probability—to solve optimization problems using greedy, primal–dual, LP-relaxation, and approximate counting methods. (P.I. – 1.1.1)* *LO 3.2: Apply principles of computer science to solve NP-hard problems through parameterized complexity analysis and kernelization techniques. (P.I.- 1.4.1)* *LO 3.3: Identify the objectives and complexity aspects of problems involving reductions, PCP-based hardness, and approximation barriers. (P.I. – 2.1.1)* *LO 3.4: Identify appropriate existing approximation and counting methods (greedy, LP-relaxation, MCMC) with justified assumptions for solving hard problems. (P.I.- 2.2.3)* *LO 3.5: Design and investigate solution strategies for hard computational problems using reductions, approximation methods, counting techniques, and kernelization, effectively communicating findings and continuously updating knowledge with emerging algorithmic advances. (PI 3.1.1, P.I. - 3.2.1, P.I.- 4.1.1, PI- 4.3.1, P.I- 9.1.2, P.I- 9.1.3, 11.1.1, 11.1.2)*	
04.	**Parallel and Distributed Algorithms**	**7-9**
	Learning Objectives: *Learners are expected to design, analyze, and evaluate algorithms for concurrent processing, data distribution, and synchronization, aiming to improve efficiency, scalability, and fault tolerance in large-scale computing systems.*	
	Contents: 4.1 Models of Parallel Computation: PRAM (EREW, CREW, CRCW), work-depth model 4.2 Parallel Algorithm Design: Parallel prefix sums, sorting, graph algorithms 4.3 Distributed Algorithms: Synchronization, consensus, leader election, Distributed graph algorithms (MIS, coloring, spanning trees)	
	Self-Learning Topics: *Map Reduce and modern large-scale distributed computation models*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply the numerical and analytical techniques to estimate work, depth, and speedup metrics for parallel algorithms. (P.I.- 1.1.1)* *LO 4.2: Apply concepts of probability and statistics concepts to solve problems related to randomized elements in distributed algorithms (P.I.- 1.1.2)* *LO 4.3: Identify the distributed algorithm for synchronization, consensus, and fault tolerance to enhance reliability and system performance. (P.I. – 2.1.2)* *LO 4.4: Identify appropriate existing approximation and counting methods (greedy, LP-relaxation, MCMC) with justified assumptions for solving hard problems. (PI 2.2.3)* *LO 4.5: Identify objectives of parallel and distributed algorithmic problems, choose appropriate procedures and test cases for experimentation, identify suitable engineering tools, and recognize gaps requiring further independent learning. (PI 2.1.1, PI 4.3.1, PI 4.3.4, P.I. 5.1.1, P.I- 5.1.2, 11.1.1, 11.1.2)*	
05.	**Game-Theoretic and Strategic Algorithm Design**	**6-8**
	Learning Objective/s: *Learners are expected to design strategic interactions among rational agents, analyze equilibria such as Nash equilibrium, and design algorithms that ensure fairness, efficiency, and stability in competitive or cooperative multi-agent systems.*	
	Contents: 5.1 Game-Theoretic Algorithms: Nash equilibria, computational aspects, Mechanism design, truthful mechanisms	

	5.2 Algorithms in Strategic Environments : Auction algorithms (Vickrey-Clarke-Groves), Congestion games and pricing algorithms, Applications in internet routing, cloud markets.	
	Self-Learning Topics: *Bayesian mechanism design and incentive-compatible algorithms*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply discrete mathematical ideas such as utilities and payoffs to solve problems on Nash equilibria. (P.I. 1.1.1)* *LO 5.2: Apply theoretical computer science principles to address case studies based on mechanism design and truthful auction algorithms. (P.I. 1.4.1)* *LO 5.3: Identify the objectives and constraints in strategic environments such as auctions, routing, or cloud markets. (P.I.-2.1.1)* *LO 5.4: Compare different game-theoretic solution methods such as VCG auctions, congestion pricing, and truthful mechanisms to select a suitable approach. (P.I.- 2.2.4)* *LO 5.5: Evaluate problem statements and analyze objectives for designing game-theoretic or auction-based mechanisms, identify suitable analytical or simulation tools, document results clearly, and recognize knowledge gaps requiring independent learning. (P.I.- 2.1.1, P.I.- 5.1.1, P.I- 5.1.2, P.I- 9.1.2, P.I- 9.3.1, 11.1.1, 11.3.1)*	
06.	**Quantum Algorithms and Emerging Paradigms** ***Learning Objective/s:*** *Learners are expected to analyze new paradigms like quantum algorithms and design hybrid algorithms and present the insights..*	**6-8**
	Contents: 6.1 Basics of Quantum Computation : Qubits, gates, measurement, Quantum complexity classes (BQP, QMA) 6.2 Quantum Algorithms: Deutsch-Jozsa, Grover's Search, Shor's Factoring Algorithm 6.3 Hybrid Classical–Quantum Approaches, Variational quantum algorithms (VQE, QAOA), Potential applications in optimization and ML	
	Self-Learning Topics: *Quantum error correction codes*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply linear algebra concepts to represent and manipulate qubits, quantum gates, and quantum states. (P.I- 1.1.1)* *LO 6.2: Apply probabilistic reasoning to interpret quantum measurement outcomes and their impact on algorithm behavior. (P.I- 1.1.2).* *LO 6.3: Compare classical and quantum approaches to select the most suitable algorithmic method. (P.I- 2.2.4)* *LO 6.4: Apply mathematical analysis to evaluate the efficiency and complexity of quantum algorithms and hybrid quantum–classical workflows.(PI 2.4.1)* *LO 6.5 Identify objectives of quantum computation problems, select appropriate quantum/classical tools for analysis, apply teamwork norms effectively during implementation, and recognize knowledge gaps that require independent learning. (P.I. 2.1.1, P.I.- 5.1.1, P.I- 5.1.2, 8.2.3, 8.3.1, 11.1.2, 11.3.1)*	

	Course Conclusion: This course equips learners with advanced algorithmic skills spanning probabilistic, approximation, parallel, game-theoretic, and quantum paradigms, enabling them to tackle modern computational challenges. It fosters analytical thinking, design competence, and multidisciplinary problem-solving essential for research, innovation, and real-world engineering applications.	**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
1.1.2	Apply the concepts of probability, statistics and queuing theory in modelling of computer-based
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
2.1.3	Identify mathematical algorithmic knowledge that applies to a given 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
2.4.1	Applies engineering mathematics to implement the solution.
3.1.1	Able to define a precise problem statement with objectives and scope.
3.2.1	Able to explore design alternatives.
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
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
4.3.4	Synthesize information and knowledge about the problem from the raw data to reach
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
6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
8.2.3	Listen to other members
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
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
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
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
11.1.1	Describe 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

Course Outcomes: A learner will be able to –

1. Analyze advanced algorithms by applying mathematical foundations like randomness and probability *(LOs: 1.1, 1.2,.1.3, 1.4, 1.5)*
2. Design randomized and probabilistic algorithms to model, simulate, and optimize computational and network reliability problems with balanced accuracy and efficiency. *(LOs: 2.1, 2.2,.2.3, 2.4,2.5)*
3. Develop approximation, counting, and kernelization strategies to evaluate and optimize solutions for NP-hard and intractable problems by analysing computational hardness and (LOs: *(LOs: 3.1, 3.2,.3.3, 3.4, 3.5)*
4. Design parallel and distributed algorithms to enhance computational efficiency, scalability, and reliability in complex networked systems. *(LOs: 4.1, 4.2,.4.3, 4.4, 4.5)*
5. Develop game-theoretic and mechanism design algorithms to achieve fairness, efficiency, and optimal decision-making in strategic and multi-agent environments. *(LOs: 5.1, 5.2, 5.3, 5.4, 5.5)*
6. Design quantum and hybrid quantum–classical algorithms and effectively communicate their applications in optimization, cryptography, and machine learning. *(LOs: 6.1, 6.2, 6.3, 6.4, 6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC7021.1	3	3	--	--	--	3	--	--	3	--	3
CEPEC7021.2	3	3	--	3	--	--	--	3	3	--	--
CEPEC7021.3	3	3	3	3	--	--	--	--	3	--	3
CEPEC7021.4	3	3	--	3	3	--	--	--	--	--	3
CEPEC7021.5	3	3	--	--	3	--	--	--	3	--	3
CEPEC7021.6	3	3	--	--	3	--	--	3	--	--	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**	**3**	**--**	**3**

Text Books :

1. Approximation Algorithms by Vijay V. Vazirani
2. Parameterized Algorithms by Cygan, Fomin, Kowalik, Lokshtanov, Marx, Pilipczuk, Pilipczuk, and Saurabh
3. Introduction to Algorithms by Cormen, Leiserson, Rivest, and Stein
4. Introduction to Parallel Algorithms and Architectures, Joseph JaJa
5. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang

Reference Books :

1. Randomized Algorithm, Rajeev Motwani & Prabhakar Raghavan
2. Distributed Algorithms: Principles, Algorithms, and Systems, Ajay D. Kshemkalyani & Mukesh Singhal
3. Algorithmic Game Theory, Noam Nisan, Tim Roughgarden, Eva Tardos & Vijay V. Vazirani
4. Quantum Computing and Quantum Machine Learning for Engineers and Developers, Jesse Van Griensven Thé, Roydon Andrew Fraser, Jose Rosas-Bustos

Other Resources :

1. https://onlinecourses.nptel.ac.in/noc23_cs63/preview
2. https://study.iitm.ac.in/ds/course_pages/BSCS4021.html
3. https://www.coursera.org/learn/game-theory-1
4. https://home.ttic.edu/~avrim/AGT24/

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: 5 Marks.
   Class Test: 5 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	CEPEC7041	APPLIED DATA 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:

1. CEPEC5011-Data Mining & Business Intelligence
2. CEPEC6021-Machine Learning

Program Outcomes addressed:

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

Course Objectives:

1	To introduce students to the fundamental concepts of Data Science, its process, and its applications across domains.
2	To enable learners to perform data exploration using descriptive statistical techniques and visual analytics.
3	To develop students' ability to apply inferential statistical methods for drawing meaningful conclusions from data.
4	To train learners in regression modelling, evaluation of model performance, and interpretation of predictive relationships.
5	To facilitate students' understanding of anomaly detection techniques and their application in identifying unusual patterns in data.
6	To equip learners with the knowledge and skills required for analysing and forecasting time-dependent data using time series models.

Module	Details	Hrs
	Course Introduction Applied Data Science provides a comprehensive understanding of the concepts, tools, and methodologies used to interpret data, identify patterns, and support evidence-based decision-making. The course introduces learners to the complete data science workflow, encompassing data acquisition, preparation, exploration, modelling, and evaluation. It emphasizes essential statistical techniques, regression methods, anomaly detection approaches, and time series forecasting to illustrate how analytical insights are generated from real-world datasets. By integrating conceptual understanding with practical relevance, the course equips students with the analytical skills necessary for advanced study and application in fields such as machine learning, artificial intelligence, and data-driven research.	**01**

01.	**Introduction to Data Science** ***Learning Objectives:*** *To introduce the fundamental concepts of Data Science, its process, and the motivation for using data-driven techniques.*	**04**
	Contents: 1.1 Introduction to Data Science, Data Science Process 1.2 Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples 1.3 Overview of Data Preparation, 1.4 Model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping 1.5 Difference between data science and data analytics. 1.6 Applications of Data Science	
	Self-Learning Topics: *Roles in Data Science: Data Engineer, ML Engineer, Analyst. Real-world Case Studies (Healthcare, Finance, Transportation, Recommender Systems).*	
	Learning Outcomes: *A learner will be able to* *LO 1.1 - Apply the knowledge of discrete structures, linear algebra, statistics, and numerical techniques to interpret fundamental data characteristics such as volume, dimensionality, and complexity. (PI 1.1.1)* *LO 1.2-Apply engineering fundamentals to explain the core concepts of Data Science, its overall process, and the motivation for adopting data-driven approaches. (PI 1.3.1)* *LO 1.3- Evaluate a given data-related problem statements and determine the required analysis, while continually learning and adapting to new data science tools and techniques. (PI 2.1.1, PI 11.1.1)* *LO 1.4- Apply computer engineering principles to outline appropriate data science procedures and basic model evaluation methods such as cross-validation, K-fold, and bootstrapping, while remaining aware of ongoing technological advancements in the field. (PI 2.3.1, PI 11.2.2)*	
02.	**Data Exploration using Descriptive Statistics** ***Learning Objective/s:*** *To provide learners with the knowledge to explore and summarize data using descriptive statistics, and to cultivate the ability to interpret patterns through appropriate graphical methods.*	**12**
	Contents: 2.1 Types of data, Properties of data 2.2 Statistical data–Classification, Tabulation, Diagrammatic & Graphic representation of data 2.3 Univariate Exploration: Measure of Central Tendency, Measure of Spread, Symmetry, Skewness: Karl Pearson Coefficient of skewness, Bowley 's Coefficient, Kurtosis 2.4 Multivariate Exploration: Central Data Point, Correlation, Different forms of correlation, Karl Pearson Correlation Coefficient for bivariate distribution. 2.5 Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart.	

	Self-Learning Topics: *Shape of distributions: heavy-tailed, light-tailed, multimodal distributions. Advanced visualizations: Violin Plot, Boxen Plot, Pair plot, Heatmaps.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1-Apply the knowledge of statistics and numerical techniques to classify, tabulate, and summarize different types and properties of data. (PI 1.1.1)* *LO 2.2-Apply the concepts of probability and statistics to compute and interpret measures of central tendency, dispersion, skewness, kurtosis, and correlation.* *(PI 1.1.2)* *LO 2.3-Evaluate a given dataset to identify key objectives by examining univariate and multivariate characteristics using appropriate statistical measures. (PI 2.1.1)* *LO 2.4-Analyze and interpret data patterns using contemporary visualization tools through histograms, scatter plots, scatter matrices, bubble charts, and other graphical representations. (PI 2.4.2)* *LO 2.5-Identify suitable modern tools and techniques for performing univariate and multivariate data visualization. (PI 5.1.1)* *LO 2.6-Demonstrate proficiency in using appropriate data visualization tools to create histograms, scatter plots, bubble charts, and other graphical representations. (PI 5.2.2)*	
03.	**Data Exploration using Inferential Statistics** ***Learning Objective/s:*** *To provide learners with the knowledge to apply inferential statistical methods for drawing conclusions from data, and to cultivate the ability to select appropriate hypothesis tests for valid decision-making.*	**06**
	Contents Overview of Various forms of distributions: Normal, Poisson, Test Hypothesis, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, ANOVA	
	Self-Learning Topics: *Neyman-Pearson lemma-MP and UMP tests. Practical examples using Python/Excel/R.*	
	Learning Outcomes: *Learner should be able to* *LO 3.1-Apply the knowledge of statistics and numerical techniques to describe and analyse probability distributions such as normal and Poisson distributions. (PI 1.1.1)* *LO 3.2-Apply the concepts of probability and statistics to compute confidence intervals and perform hypothesis tests such as Z-test, t-test, and ANOVA. (PI 1.1.2)* *LO 3.3-Identify appropriate statistical methods and hypothesis testing procedures by determining the mathematical requirements of the given problem. (PI 2.1.3)* *LO 3.4-Arrive at valid statistical conclusions by interpreting test statistics, p-values, confidence levels, and the implications of Type-I and Type-II errors. (PI 2.4.4)*	
04.	**Regression Analysis** ***Learning Objective/s:*** *To provide learners with the knowledge to build and interpret regression models, and to cultivate the ability to evaluate model performance using appropriate statistical measures.*	**10**

	Contents: 4.1 Mathematical and Statistical Equation – Meaning of Intercept and Slope 4.2 Error term – Measure for Model Fit –R2 – MAE – MAPE. 4.3 Multiple Linear Regression Model, 4.4 Partial Regression Coefficients, 4.5Testing Significance overall significance of Overall fit of the model, 4.6 Testing for Individual Regression Coefficients	
	Self-Learning Topics: *Residual analysis and its importance in regression diagnostics. Real regression case studies (house prices, sales forecasting).*	
	Learning Outcomes: *A learner will be able to* *LO 4.1-Apply the knowledge of statistics and numerical techniques to construct regression equations and interpret parameters such as intercept, slope, and error term. (PI 1.1.1)* *LO 4.2-Apply the concepts of probability and statistics to compute model fit metrics such as R^2, MAE, and MAPE, and interpret their significance. (PI 1.1.2)* *LO 4.3-Identify appropriate mathematical and statistical methods required for selecting suitable regression models such as simple, multiple, and partial regression. (PI 2.1.3)* *LO 4.4-Analyze and interpret regression model outcomes using contemporary tools to assess significance of coefficients and overall model performance. (PI 2.4.2)* *LO 4.5-Explore alternative regression model designs by examining different model structures and variable selections for meeting analytical requirements. (PI 3.2.1)* *LO 4.6-Perform systematic evaluation of regression models by comparing fit statistics, significance tests, and error measures to select the optimal design. (PI 3.3.1)*	
05.	**Anomaly Detection** ***Learning Objective/s:*** *To provide learners with the knowledge to identify and detect anomalies in data, and to cultivate the ability to apply appropriate statistical and distance-based techniques for recognizing unusual patterns.*	**06**
	Contents: 5.1 Outliers, Causes of Outliers, 5.2 Anomaly detection techniques, 5.3 Outlier Detection using Statistics 5.4 Outlier Detection using Distance based method, 5.5 Outlier detection using density-based methods, 5.6 SMOTE	
	Self-Learning Topics: *Introduction to autoencoders for anomaly detection, Performance metrics for anomaly detection (AUC-PR, F1, confusion matrix).*	

	Learning Outcomes: *A learner will be able to* *LO 5.1-Apply statistical knowledge to explain the concept of outliers and identify their possible causes in real-world datasets. (PI 1.1.1)* *LO 5.2 -Apply probability and statistical techniques to detect anomalies using distribution-based and statistical thresholding methods. (PI 1.1.2)* *LO 5.3 -Identify appropriate mathematical and algorithmic approaches for detecting outliers using distance-based and density-based methods. (PI 2.1.3)* *LO 5.4-Analyze and interpret results of anomaly detection techniques using contemporary analytical tools and visualizations. (PI 2.4.2)* *LO 5.5-Explore alternative anomaly detection designs, including statistical, distance-based, and density-based techniques, to address varied data scenarios. (PI 3.2.1)* *LO 5.6 -Perform systematic evaluation of anomaly detection methods, including SMOTE for class imbalance, to determine the most effective solution. (PI 3.3.1)* *LO 5.7 -Identify suitable modern engineering and data science tools required for implementing anomaly detection algorithms effectively. (PI 5.1.1)* *LO 5.8 -Demonstrate proficiency in using discipline-specific tools for implementing anomaly detection techniques and interpreting their outputs. (PI 5.2.2)*	
06.	**Time Series Forecasting** ***Learning Objective/s:*** *To provide learners with the knowledge to analyze and model time-dependent data, and to cultivate the ability to apply suitable forecasting techniques for predicting future trends.*	**05**
	Contents: 6.1 Taxonomy of Time Series Forecasting methods, Time Series Decomposition 6.2 Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, 6.3 Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	
	Self-Learning Topics: *Seasonal decomposition, Stationarity concept and tests.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1 -Apply statistical and numerical techniques to interpret the taxonomy of time series forecasting methods and the components of time series decomposition such as trend, seasonality, and irregular variations. (PI 1.1.1)* *LO 6.2 -Apply concepts of probability and statistics to implement smoothing methods such as the average method, moving average smoothing, and exponential approaches for analysing time-dependent data. (PI 1.1.2)* *LO 6.3 -Identify appropriate mathematical and statistical methods, including linear regression and ARIMA, required for selecting suitable time series forecasting models. (PI 2.1.3)* *LO 6.4-Analyze and interpret time series model outputs using contemporary analytical tools to understand forecast patterns and model behaviour. (PI 2.4.2)* *LO 6.5-Identify modern analytical and visualization tools required for building, analysing, and validating time series forecasting models. (PI 5.1.1)* *LO 6.6-Demonstrate proficiency in using discipline-specific tools to implement time series models, generate forecasts, and visualize predictions effectively. (PI 5.2.2)*	
	Course Conclusion The Applied Data Science course concludes by equipping learners with a solid understanding of how data-driven insights are derived through systematic statistical and analytical methods. Students gain the ability to explore and interpret datasets, perform valid inferential analysis, build and assess predictive and forecasting models, and detect	01

	anomalies in real-world data. By integrating foundational theory with practical analytical skills, the course prepares learners to apply evidence-based reasoning to complex problems and establishes a strong platform for advanced study in machine learning, artificial intelligence, and data-centric research.	
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
1.1.2	Apply the concepts of probability, statistics and queuing theory in modelling of computer-based system, data and network protocols.
1.3.1	Apply engineering fundamentals
2.1.1	Evaluate problem statements and identifies objectives
2.1.3	Identify mathematical algorithmic knowledge that applies to a given problem
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.
2.4.4	Arrive at conclusions with respect to the objectives.
3.2.1	Able to explore design alternatives.
3.3.1	Able to perform systematic evaluation of the degree to which several design concepts meet the criteria.
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.2.2	Demonstrate proficiency in using discipline-specific tools
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: Learner will be able to

1 Interpret data characteristics, understand core data science foundations, analyse data problems, and outline basic analytical procedures using emerging tools and techniques. (*LOs: 1.1,1.2,1.3,1.4*)

2 Analyse univariate and multivariate data patterns using statistical and visualization techniques, and apply modern tools to summarize, interpret, and effectively represent data. (*LOs:2.1,2.2,2.3,2.4,2.5,2.6)*

3 Evaluate statistical evidence using probability distributions and hypothesis testing, and apply appropriate statistical methods to compute confidence intervals, interpret test outcomes, and draw valid conclusions. (*LOs:3.1,3.2,3.3,3.4)*

4 Assess regression models using fit metrics, significance tests, and error measures, and apply statistical and computational techniques to construct, interpret, and select appropriate regression designs for data-driven problems. *(LOs:4.1,4.2,4.3,4.4,4.5,4.6)*

5 Analyse anomaly detection methods using statistical, distance-based, density-based, and sampling-based techniques, and apply analytical and computational tools to identify, interpret, and implement effective outlier detection solutions. (*LOs:5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8)*

6 Analyse time series forecasting methods and model behaviours using smoothing techniques, regression-based and ARIMA approaches, and apply modern analytical tools to build, interpret, and validate forecast models effectively. (*LOs:6.1,6.2,6.3,6.4,6.5,6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC7041.1	3	3	--	--	--	--	--	--	--	--	3
CEPEC7041.2	3	3	--	--	3	--	--	--	--	--	--
CEPEC7041.3	3	3	--	--	--	--	--	--	--	--	--
CEPEC7041.4	3	3	3	--	--	--	--	--	--	--	--
CEPEC7041.5	3	3	3	--	3	--	--	--	--	--	--
CEPEC7041.6	3	3	--	--	3	--	--	--	--	--	--
Average	3	3	3	--	3	--	--	--	--	--	3

Text Books:

1. Vijay Kotu, Bala Deshpande. Data Science Concepts and Practice‖, Elsevier, M.K. Publishers.
2. Agarwal, B.L. (2006): Basic Statistics. Wiley Eastern Ltd., New Delhi
3. Gupta, S. P. (2011): Statistical Methods. Sultanchand &Sons, New Delhi

Reference Books:

1. Sivathanupillai, M &Rajagopal, K. R. (1979):-Statistics for Economics Students
2. Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, ―Comprehensive Statistical Methods‖, S.Chand Publications, New Delhi.
3. S.C. Gupta, V. K. Kapoor ―Fundamentals of Mathematical Statistics‖, S. Chand and Sons, New Delhi.

Other Resources:

1. Coursera – "Data Science Specialization" by Johns Hopkins; covers statistics, R, visualization. https://www.coursera.org/specializations/jhu-data-science
2. Google Data Analytics Certificate by Industry-level understanding of data analysis workflow. https://www.coursera.org/professional-certificates/google-advanced-data-analytics
3. MIT OpenCourseWare https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2022/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Two Class test: 05 marks each
Course Project: 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	CEPEC7042	BLOCKCHAIN	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
2. CEPCC611: Cryptography and System Security

Program Outcomes addressed:

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

Course Objectives:

1. To introduce students to the core concepts of blockchain, distributed ledgers, cryptography, and consensus mechanisms.
2. To enable learners to apply cryptographic and transaction models for analyzing blockchain security and validity.
3. To develop students' skills in designing and deploying smart contracts using Solidity and modern development environments.
4. To guide learners in analyzing public blockchain architectures like Bitcoin and Ethereum through hands-on experimentation.
5. To help students understand private blockchain frameworks, permissioned consensus algorithms, and the Hyperledger ecosystem.
6. To train learners to evaluate major blockchain platforms and design application architectures while staying updated with emerging tools and trends.

Module	Details	Hrs.
	Course Introduction This course provides a comprehensive foundation in blockchain fundamentals, cryptography, smart contracts, public and private blockchain architectures, enterprise blockchain platforms, and real-world applications. Through modern development tools, learners gain practical skills in designing blockchain solutions across domains such as finance, supply chain, identity management, and healthcare. The course equips students with both analytical and implementation-oriented competencies necessary to work with emerging blockchain technologies and evolving industry trends	**01**
01.	**Fundamentals of Blockchain**	**6-8**
	Learning Objective: *To introduce blockchain core concepts and ecosystem*	

	Contents: 1.1 Core Concepts: What is Blockchain, Evolution & Origin, Distributed Ledger Technology, Cryptographically Secure Hash Functions, Merkle Trees, Blockchain Structure (block, chain, linking) 1.2 Blockchain Ecosystem: Components of Blockchain, Types of Blockchains, Nodes: Full, Light, Miner Nodes, Consensus Fundamentals, Limitations & Challenges of Blockchain	
	***Self-Learning Topics**: Scalability Trilemma*	
	***Learning Outcomes:** A learner will be able to* *LO 1.1 Apply engineering fundamentals to explain the core concepts, cryptographic foundations, structural elements, and ecosystem components of blockchain technology. (PI 1.3.1)* *LO 1.2 Apply blockchain fundamental concepts to explore its ecosystem and recognize the importance of staying current with emerging developments. (PI 1.4.1)*	
02.	**Cryptography & Cryptocurrency Mechanisms**	**6-8**
	Learning Objective: *To provide students with the knowledge to identify existing blockchain consensus mechanisms and to cultivate awareness of continuously updating themselves with emerging technologies for accurate assessment of their applicability.*	
	Contents: 2.1 Cryptography basics: Hashing (SHA-256), Digital Signatures, Public & Private Keys 2.2 Cryptocurrency Concepts: Altcoins, Tokens (Utility, Security, Governance), Wallets (Hot & Cold), Transactions in Blockchain, UTXO Model, Account-Based Model, Double-Spending Problem 2.3 Gas Fees & Transaction Costs 2.4 Consensus and Mining: Introduction to Consensus, Types of Consensuses (PoW, PoS, PoET, PoA, BFT Family), Mining Principles, Mining Difficulty, Mining Rewards, Mining Pools	
	***Self-Learning Topics:** Elliptic Curve Cryptography*	
	***Learning Outcomes:** A learner will be able to* *LO 2.1 Apply engineering fundamentals to explain cryptographic concepts, transaction models, gas fees, and blockchain consensus and mining principles. (PI 1.3.1)* *LO 2.2 Apply the concepts of cryptographic hashing, digital signatures, and key mechanisms to model secure blockchain transactions and data validation processes. (PI 1.4.1)* *LO 2.3 Identify mathematical and algorithmic principles behind cryptocurrency transaction models such as UTXO, account-based systems, and double-spending prevention. (PI 2.1.3)* *LO 2.4 Identify existing consensus mechanisms (PoW, PoS, PoA, BFT variants) and recognize the need to stay updated with emerging blockchain technologies for informed evaluation of their applicability. (PI 2.2.3, PI 11.1.1, PI 11.2.2)*	
03.	**Smart Contracts & Blockchain Programming**	**8-9**
	Learning Objective: *To enable students to understand smart contract concepts, develop Solidity programming skills, utilize blockchain development tools, and apply these competencies through practical case studies and mini-projects.*	
	3.1 Smart Contracts Overview: Definition & Purpose, Types, Architecture & Structure, Smart Contract Lifecycle, Limitations & Risks 3.2 Solidity Programming: Solidity Basics, Functions, State Variables & Storage, Qualifiers (Visibility, Activity), Address & Address Payable, Bytes & Enums, Arrays (Fixed, Dynamic), Strings & Bytes, Arrays, Struct, Mapping, Inheritance, Error Handling	

	3.3 Tools & Development Environment: Remix IDE, Truffle Framework 3.4 Case Study & Mini Project: Voting Smart Contract, Smart Contract Deployment Guide	
	Self-Learning Topics: *Events & Logging, Hardhat*	
	Learning Outcomes: *A learner will be able to* *LO 3.1 Apply the theory and principles of computer science to understand smart contract concepts, types, architecture, lifecycle, and associated risks. (PI 1.3.1)* *LO 3.2 Apply the theory and principles of blockchain to implement smart contracts. (PI 1.4.1)* *LO 3.3 Compare and contrast alternative solution/methods to select the best methods such as structs, mappings, arrays, inheritance, error handling, visibility, payable functions (PI 2.2.4)* *LO 3.4 Formulate and construct Solidity-based modules using functions, variables, arrays, structs, mappings, inheritance, and error-handling mechanisms. (PI 2.3.1)* *LO 3.5 develop and document detailed smart-contract requirements and translate them into a structured design suitable for implementation (PI 3.1.6)* *LO 3.6 Implement and integrate smart contract modules to develop complete contract-based solutions such as voting applications and mini-projects. (PI 3.4.2)* *LO 3.7 Demonstrate proficiency in using modern blockchain tools such as Remix IDE and Truffle Framework, and recognize the need to stay updated with emerging practices. (PI 5.2.2, PI 11.2.2)* *LO 3.8 Analyze the limitations of blockchain-based smart contract solutions and validate the credibility of results obtained from modern development tools such as Remix, Hardhat, and Truffle (PI 5.3.2, PI 11.1.1,)*	
04.	**Public Blockchains: Bitcoin and Ethereum**	**6-7**
	Learning Objectives: *To Enable students to analyze public blockchains, compare Bitcoin and Ethereum architectures, and apply blockchain development tools for hands-on experimentation.*	
	Contents: 4.1 Public Blockchain Overview 4.2 Bitcoin Blockchain: Bitcoin Architecture, Bitcoin Transactions, Consensus in Bitcoin (PoW), Mining in Bitcoin, Miner's Workflow, Mining Pools and Methods, Bitcoin Limitations & Scaling 4.3 Ethereum Architecture: EVM, Accounts, Gas, Transactions, Comparison: Bitcoin vs Ethereum 4.4 Tools & Test Networks: MetaMask, Remix, Ganache, Etherscan	
	Self-Learning Topics: *NFTs, token standards (ERC-20, ERC-721), cross-chain interoperability, and decentralized autonomous organizations (DAOs).*	
	Learning Outcomes: *A learner will be able to* *LO 4.1 Review blockchain concepts to derive cryptographic foundations, transaction models, gas fee mechanisms, and consensus–mining principles. (PI 3.1.3)* *LO 4.2 Evaluate and compare Bitcoin and Ethereum blockchain architectures against criteria such as scalability, security, decentralization, and cost to determine their effectiveness for secure and efficient transactions (PI 3.3.1)* *LO 4.3 Perform experimental deployment of smart contracts using MetaMask, Remix, Etherscan & Ganache test networks. (PI 5.1.2, PI 11.1.1)* *LO 4.4 Use blockchain development tools efficiently while actively upgrading skillset to keep pace with new trends. (PI 5.2.2, PI 11.2.2)*	
05.	**Private Blockchains: Hyperledger**	**8-9**
	Learning Objective/s: *To enable students to understand private blockchain fundamentals, explore permissioned consensus models, and gain practical knowledge of the Hyperledger ecosystem, Fabric components, transaction flow, and real-world applications.*	

	Contents: 5.1 Private Blockchain Concepts: Characteristics & Need, Permissioned vs Permissionless, Smart Contracts in Private Networks, State Machine Replication 5.2 Consensus for Permissioned Blockchains: PAXOS, RAFT, BFT, PBFT 5.3 Hyperledger Ecosystem: Introduction to Hyperledger, Hyperledger Tools & Frameworks, Hyperledger Fabric Overview, Components (MSP, Chaincode, Ledger, Peers & Orderers), Transaction Flow, Hyperledger Fabric Network Setup, 5.4 Case Study: Supply Chain Management Application using Hyperledger Fabric	
	Self-Learning Topics: *Proof-of-Authority (PoA)*	
	Learning Outcomes: *A learner will be able to* *LO 5.1 Apply engineering principals to understand the private blockchain concepts (PI 1.3.1)* *LO 5.2 Apply blockchain concepts to understand private blockchain characteristics, permissioned network models, and Hyperledger architecture. (PI 1.4.1)* *LO 5.3 Analyze and compare consensus mechanisms used in permissioned blockchains such as PAXOS, RAFT, BFT, and PBFT using algorithmic reasoning (PI 2.1.3, PI 11.1.1,)* *LO 5.4 Compare and contrast private blockchain consensus methods for enterprise use cases (PI 2.2.4, PI 11.2.2,)*	
06.	**Blockchain Platforms & Applications**	**8-9**
	Learning Objectives: *To introduce students to key blockchain platforms and help them analyze how these technologies solve problems in DeFi, supply chain, identity, healthcare, and finance.*	
	Contents: 6.1 Blockchain Platforms: Corda, Ripple, Quorum 6.2 Applications of Blockchain: Decentralized Finance (DeFi), Blockchain for Supply Chain, Identity Management, Healthcare, Finance, Real Estate	
	Self-Learning Topics: Polygon, Solana	
	Learning Outcomes: *A learner will be able to* *LO 6.1 Analyze and compare blockchain platforms such as Corda, Ripple, and Quorum to determine the most suitable platform for specific real-world use cases. (PI 2.2.4)* *LO 6.2 Identify relevant information about blockchain platforms and application domains to formulate suitable platform choices for enterprise use cases (PI 2.4.3)* *LO 6.3 Explore blockchain platform capabilities to determine suitable architectural solutions for implementing enterprise applications in diverse domains. ((PI 3.3.1)* *LO 6.4 Design application architecture using selected blockchain platforms for domains like DeFi, Supply Chain, Healthcare, Identity Management, and Real Estate (PI 3.4.1)* *LO 6.5 Select and configure appropriate tools or frameworks required for blockchain platform deployment and testing (PI 5.1.2, PI 11.1.1)* *LO 6.6 Gain proficiency in blockchain development tools and frameworks while keeping pace with technological advancements and emerging application trends such as DeFi and digital asset tokenization (PI 5.2.2, PI 11.2.1)*	

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
2.1.3	Identify mathematical algorithmic knowledge that applies to a given 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
2.3.1	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.
3.1.6	Able to develop software requirement specifications (SRS).
3.1.3	Able to review state-of-the-art literature to synthesize system requirements.
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.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2.2	Demonstrate proficiency in using discipline-specific tools
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 fundamental blockchain concepts to explore and understand the components of the blockchain ecosystem. (LO 1.1, LO 1.2)

2. Apply cryptographic techniques and transaction models, and identify consensus mechanisms to design, validate, and evaluate secure blockchain systems. (LO 2.1, LO 2.2, LO 2.3, LO 2.4)

3. Develop and validate smart-contract–based blockchain solutions using Solidity and modern development tools. (LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6, LO 3.7)

4. Apply analytical and practical skills to evaluate architectures and deploy smart contracts *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*

5. Explore the architecture of private blockchains and analyze key consensus protocols to determine their suitability for permissioned networks. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*

6. Analyze blockchain platforms, design domain-specific architectures *(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
CEPEC7042.1	3										
CEPEC7042.2	3	3									3
CEPEC7042.3	3	3	3		3						3
CEPEC7042.4			3		3						3
CEPEC7042.5	3	3									3
CEPEC7042.6		3	3		3						3
Average	**3**	**3**	**3**		**3**						**3**

Textbooks:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing

Reference Books:

1. Blockchain for Beginners, Yathish R and Tejaswini N, SPD
2. Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
3. Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Other Resources:

1. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
2. https://www.hyperledger.org/use/fabric
3. NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment-Theory (20 Marks)**
   1. Two Class test: 05 marks each
   2. Course Project: 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% to 30% weightage and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC7043	ADHOC 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 familiarize learners with the fundamental concepts of wireless communication and ad hoc networks.
2. To facilitate learners to apply the concepts of various MAC, routing, and multicast protocols for achieving efficient, adaptive, and reliable communication in ad hoc wireless environments.
3. To familiarize learners with transport layer principles and security mechanisms for ensuring end-to-end reliability and confidentiality in wireless communication.
4. To impart an understanding of system security concepts required to recognize and prevent malicious code.
5. To explore Quality of Service (QoS) frameworks, energy management strategies, and emerging technologies such as IoT, VANETs, and Cognitive Radio Ad Hoc Networks.

Module	Details	Hrs.
	Course Introduction Ad Hoc and Wireless Networks enable dynamic, infrastructure less communication through self-organizing and adaptive networking systems. This course provides foundational and applied knowledge of MAC, routing, transport, QoS, and security protocols essential for reliable wireless communication. It emphasizes system design, performance optimization, and security in distributed network environments while exploring emerging technologies such as IoT, VANETs, and Cognitive Radio Networks.	
01.	**Introduction to Wireless and Ad Hoc Networks**	**6-8**
	Learning Objective: *To explore the principles of wireless communication and the fundamentals of ad hoc networking.*	

	Contents: 1.1 Fundamentals of Wireless Communication Technology, Electromagnetic Spectrum, GSM, GPRS, PCS, WLAN, UMTS, Components of Packet Radios, Routing in PRNETs, Route Calculation and Pacing Techniques. 1.2 Ad Hoc Wireless Networks – Overview and Architecture, Heterogeneity in Mobile Devices, Wireless Sensor Networks, Traffic Profiles, Types of Ad Hoc Mobile Communications. 1.3 Types of Mobile Host Movements, Challenges Facing Ad Hoc Mobile Networks.	
	Self-Learning Topics: *Mobile IP, MANET characteristics.*	
	Learning Outcomes: *A learner will be able to* *LO 1.1: Identify the need and significance of GSM, GPRS, WLAN, and UMTS systems in the design and development of wireless networks. (P.I.-2.2.2)* *LO 1.2: Use the principles of engineering to understand the basic architecture, operation, and key characteristics of ad hoc wireless networks (P.I.-1.3.1)* *LO 1.3: Analyze appropriate tools and techniques used in ad hoc networking and mobility management (P.I.- 2.1.2).* *LO 1.4: Explore the applications, benefits, and limitations of wireless ad hoc systems in diverse environments, and explain how this exploration fosters lifelong learning and adaptability in designing different network architectures. (P.I.-3.2.1), (P.I.-11.1.1)* *LO 1.5: Apply fundamental engineering concepts to examine how different types of mobile host movement affect network stability and routing efficiency in an ad hoc wireless network, and clearly explain why it is vitally important to keep current with new developments in mobility models and routing technologies (P.I.-1.4.1), (P.I.-11.2.2)* *LO 1.6: Verify the functionalities of key wireless technologies and validate how mobile host movements influence the design of ad hoc network architectures. (P.I.-3.4.3)*	
02.	**Medium Access Control (MAC) Protocols** ***Learning Objective:*** *To acquaint learners with MAC design issues and evaluate protocols that ensure efficient and fair channel access.*	**6-8**
	Contents: 2.1 Introduction to MAC Protocols, Synchronous and Asynchronous MAC Protocols. 2.2 Problems in Ad Hoc Channel Access, Receiver-Initiated and Sender-Initiated MAC Protocols, Contention-Based and Scheduling-Based Approaches, Power-Aware MAC, Multichannel MAC. 2.3 Performance Analysis of Existing Ad Hoc MAC Protocols such as MACA, MACAW, IEEE 802.11 DCF.	
	Self-Learning Topics: *QoS-based MAC schemes, TDMA-based protocols.*	
	Learning Outcomes: *A learner will be able to* *LO 2.1: Apply the engineering knowledge to understand objectives and structural classification of MAC protocols in ad hoc wireless environments. (P.I.-1.3.1)* *LO 2.2: Compare and contrast alternative solution processes used in synchronous, asynchronous, and hybrid MAC mechanisms, and justify the selection of the most suitable process for wireless network performance. (P.I.- 2.2.5)* *LO 2.3 Identify the performance metrics such as delay, throughput, and fairness to assess the efficiency of MAC protocols in wireless networks. (P.I.-2.2.2)* *LO 2.4: Apply fundamental engineering concepts to analyze MAC protocol design issues in ad hoc networks and explain how different synchronous, asynchronous, contention-based, and scheduling-based MAC approaches*	

	impact overall network performance. (P.I.-1.4.1)	
03.	**Routing Protocols in Ad Hoc Networks** ***Learning Objective:*** *To acquaint learners with basic understanding and analysis of various routing protocols for efficient and adaptive data transmission.* 3.1 Design Issues in Ad Hoc Routing, Classification of Routing Protocols: Table-Driven (DSDV, WRP, CSGR). 3.2 On-Demand (AODV, DSR, TORA, SSR, LAR). 3.3 Hybrid and Hierarchical Protocols (ZRP, Cluster-Based Routing), Power-Aware Routing, Location-Aided Routing, Route Maintenance, Performance Metrics. ***Self-Learning Topics: Reliable multicast and group communication models.*** ***Learning Outcomes:*** *A learner will be able to* *LO 3.1: Apply theory and principles of computer science to understand the challenges of routing protocols in ad hoc network (P.I.-1.4.1)* *LO 3.2: Apply engineering fundamentals to compare table-driven, on-demand, and hybrid routing protocols in ad hoc wireless networks, and state which routing approach is better based on performance. (P.I.-1.3.1)* *LO 3.3: Design energy-efficient routing mechanisms to improve throughput, reduce delay, and prolong the operational lifetime of ad hoc networks, and explain why it is vitally important to keep current with new developments in this field. (P.I.-3.4.3), (P.I.- 11.2.2)* *LO 3.4: Simulate and compare the performance of various routing protocols using suitable network simulation tools for the requirement of continuing professional development (CPD) and explain how it supports lifelong learning and adaptability to evolving technologies and professional practices. (P.I.-5.1.1), (P.I.-11.1.1)* *LO 3.5: Interpret routing protocols results to gain insights and make decisions. (P.I. -5.2.2)* *LO 3.6: Explore alternative routing protocol designs for ad hoc networks and justify which design best addresses key routing challenges such as mobility, scalability, and energy efficiency. (P.I.-3.2.1)*	**8-9**
04.	***Multicast and Geocast Routing*** ***Learning Objectives:*** *To explore multicast and geocast routing mechanisms and their performance in mobile networks.* **Contents:** 4.1 Introduction to Multicast Routing, Issues in Multicast Protocol Design, Operation of Multicast Protocols. 4.2 Architectural Reference Model, Tree-Based and Mesh-Based Multicast Routing, Energy-Efficient and QoS-Based Multicasting, Application-Dependent Multicast Routing. 4.3 Comparison of Tree and Mesh-Based Protocols, Geocast Routing and Applications. ***Self-Learning Topics: Reliable multicast and group communication models.***	**6-7**

	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply engineering fundamentals to understand the architecture and operation of multicast routing protocols. (P.I.-1.3.1)* *LO 4.2:Differentiate between tree-based and mesh-based multicasting approaches and analyze which one is better.(P.I.-2.4.4)* *LO 4.3: Identify the functionalities in multicast routing to determine the effectiveness of protocol performance in ad hoc wireless networks. (P.I.-2.2.2* *LO 4.4: Analyze QoS parameters such as delay, packet delivery ratio, and throughput in multicast and geocast routing using simulation tools. (P.I.-5.1.1)* *LO 4.5: Apply fundamental engineering concepts to explore the architecture and operation of multicast routing protocols in ad hoc wireless networks, and analyze how these concepts help in solving practical communication challenges. (P.I.-1.4.1)* *LO 4.6: Demonstrate proficiency in using discipline-specific tools by comparing tree-based, mesh-based, and geocast multicast routing approaches. (P.I.-5.2.2)*	
05.	***Transport Layer and Security Protocols***	**8-9**
	Learning Objective/s: *To study reliable data delivery mechanisms and secure communication techniques in ad hoc networks*	
	Contents: 5.1 Transport Layer Issues, TCP Behavior over Ad Hoc Networks, Design Goals of Transport Protocols, Other Transport Solutions. 5.2 Security in Ad Hoc Networks, Network Security Requirements, Attacks, Challenges in Security Provisioning, Key Management, Secure Routing Protocols, Intrusion Detection, Authentication, and Encryption.	
	Self-Learning Topics: Secure AODV, Trust-based routing frameworks.	
	Learning Outcomes: *A learner will be able to* *LO 5.1: Identify the functions, objectives, and challenges involved in the design of transport layer protocols for ad hoc wireless networks. (P.I.-2.2.2)* *LO 5.2: Evaluate the effects of node mobility and dynamic topology on TCP performance and other transport layer protocols in wireless ad hoc networks. (P.I.–2.4.4)* *LO 5.3: Apply engineering fundamentals to identify security threats in ad hoc networks and propose ethical alternatives to address unethical attack behaviors. (P.I.-1.3.1), (P.I.–7.1.1)* *LO 5.4: Apply engineering knowledge to formulate secure routing mechanisms with authentication and key management, ensuring confidentiality and integrity of transmitted data while adhering to ethical standards. (P.I.–1.4.1), (P.I.–7.2.2)*	
06.	***Quality of Service (QoS), Energy Management, and Emerging Trends***	**8-9**
	Learning Objectives: *To explore QoS frameworks, power optimization, and emerging trends in ad hoc networking.*	
	Contents: 6.1 QoS Fundamentals, Issues and Challenges in Providing QoS, QoS Metrics and Solutions, MAC and Network Layer QoS Frameworks. 6.2 Energy Management Schemes – Battery, Transmission Power, and System Power Optimization, Cross-Layer Energy Management. 6.3 Emerging Trends: WSNs, VANETs, CRAHNs, and IoT-based Ad Hoc Networks.	
	Self-Learning Topics: Machine Learning and AI for energy optimization.	
	Learning Outcomes: *A learner will be able to*	

	LO 6.1: Apply engineering fundamentals to explore the Quality of Service (QoS) requirements and possible solutions at the MAC and network layers for achieving efficient communication in ad hoc wireless networks. (P.I.-1.3.1) *LO 6.2: Analyze various energy management schemes and optimization techniques to enhance network performance and sustainability while designing the network. (P.I.- 2.1.2)* *LO 6.3 Apply engineering knowledge and continuous learning to evaluate and integrate QoS mechanisms and power control strategies for achieving reliable and energy-efficient wireless system performance. (P.I.-1.4.1* *LO 6.4: Compare and contrast alternative solution processes that use emerging technologies (IoT, VANETs, Cognitive Radio Networks) to enhance wireless communication systems, and select the most appropriate approach based on validated performance and suitability criteria.* (P.I.- 2.2.5)	

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
2.1.2	Identify and analyze appropriate tools and techniques for a given engineering problem.
2.2.2	Identifies functionalities and computing resources
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
3.2.1	Able to explore design alternatives.
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.
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. Analyze the fundamental principles, architecture, and challenges of wireless communication and ad hoc networks. (LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5)
2. Analyze various Medium Access Control (MAC), routing, and multicast protocols for reliable and scalable data communication in ad hoc environments. (LO 2.1, LO 2.2, LO 2.3)
3. Design and evaluate transport layer mechanisms and security protocols to ensure confidentiality, authentication, and integrity in ad hoc wireless networks. (LO 1.2, LO 3.1, LO 3.2, LO 3.3, LO 3.4, LO 3.5, LO 3.6)
4. Assess different network attacks and apply cryptographic and key management techniques to enhance the overall security of wireless systems. (LO 1.1, LO 1.2, LO 3.1, LO 4.1, LO 4.2, LO 4.3, LO 4.4. LO 4.5)
5. Apply Quality of Service (QoS) frameworks and energy management schemes to optimize performance and power efficiency in mobile ad hoc networks. *(LO 1.1, LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
6. Explore emerging technologies such as IoT, Vehicular Ad Hoc Networks (VANETs), Cognitive Radio Ad Hoc Networks (CRAHNs), and Wireless Sensor Networks (WSNs) for innovative wireless applications. *(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
CEPEC7043.1	3	3	3	--	--	--	--	--	--	--	3
CEPEC7043.2	3	3	--	--	--	--	--	--	--	--	--
CEPEC7043.3	3	--	3	--	3	--	--	--	--	--	3
CEPEC7043.4	3	3	--	--	3	--	--	--	--	--	--
CEPEC7043.5	3	3	--	--	--	--	3	--	--	--	--
CEPEC7043.6	3	3	--	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**--**	**3**	**--**	**3**	**--**	**--**	**--**	**3**

Textbooks:

1. Ad Hoc Wireless Networks: Architectures and Protocols, C. Siva Ram Murthy and B. S. Manoj, 2004, Pearson Education.
2. Ad Hoc Networking, Charles E. Perkins,2001, Addison-Wesley.
3. Mobile Ad Hoc Networking, Stefano Basagni, Marco Conti, Silvia Giordano, and Ivan Stojmenovic, 2004, Wiley.

Reference Books:

1. Ad Hoc Mobile Wireless Networks: Protocols and Systems, C. K. Toh, 2002, Prentice Hall.
2. Ad Hoc Mobile Wireless Networks: Principles, Protocols and Applications, Subir Kumar Sarkar, T. G. Basavaraju, and C. Puttamadappa, 2007, Auerbach Publications.
3. Wireless Communications and Networking, William Stallings, 2002, Pearson Education.
4. Wireless Ad Hoc and Sensor Networks: Theory and Applications, Rajeev Shorey, A. Ananda, Mun Choon Chan, and Wei Tsang Ooi, 2006, Wiley-IEEE Press.

Other Resources:

1. NPTEL Course: *Ad Hoc and Sensor Networks* by Prof. B. S. Manoj, Department of Avionics, IIT Palakkad. Web Link: https://nptel.ac.in/courses/106/105/106105160
2. NPTEL Course: *Wireless Communication* by Prof. Abhay Karandikar, Department of Electrical Engineering, IIT Bombay. Link: https://nptel.ac.in/courses/108/101/108101092

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (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% to 30% weightage and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
PEC	CEPEC7044	COMPILER DESIGN	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. CEPCC509- Theoretical Computer Science

Program Outcomes addressed:

1. PO1- Engineering knowledge
2. PO2- Problem analysis
3. PO3- Design/development of solutions
4. PO5- Modern Tool Usage
5. PO8- Individual and Team Work
6. PO9 – Communication
7. PO11- Life Long Learning

Course Objectives:

1. To provide an understanding of how compilers function, including the major phases involved in translating high-level programs into executable machine code..
2. To develop skills in lexical and syntax analysis, including designing tokenizers and constructing top-down and bottom-up parsers.
3. To enable learners to generate intermediate code using syntax-directed translation and backpatching techniques for expressions and control flow.
4. To apply optimization techniques and understand runtime environments, including memory management and activation records.
5. To formulate efficient code generation strategies through register allocation, basic block analysis, and peephole optimization.

Module	Details	Hrs
	Course Introduction Compiler Design provides insights into how source programs written in high-level languages are translated into efficient machine code. This course prepares students to understand compiler phases, apply grammar-based parsing, generate intermediate representations, and optimize target code essential for system software development.	**01**

01.	**Introduction to Compiler & Lexical Analysis** ***Learning Objective: Students are expected to apply the knowledge of compiler phases and write lexical programs using LEX tool.***	**7-8**
	Contents:	
	Compilers, analysis of source program, phases of compiler, Cousins of compiler, grouping of phases, Compiler construction tools. Lexical analysis - Role of lexical analyzer, input buffering, tokens, lexemes, patterns, specification of tokens, FA-based token recognition. Introduction to LEX Tool: writing LEX programs.	
	Self-Learning Topics: Applications of regular expressions, LEX-based scanner mini programs. FLEX, BISON	
	Learning Outcomes: ***A learner will be able to*** ***LO 1.1****: Apply the concept of regular expressions and lexical analyser to identify tokens, lexemes and patterns (1.4.1).* ***LO 1.2:*** *Apply engineering fundamentals to illustrate compiler phases and their functioning (1.3.1)* ***LO 1.3:*** *Compare and contrast different phases of compiler (2.2.4)* ***LO 1.4:*** *Apply the concept of lexical analyser and develop LEX program using identified tools while effectively collaborating and communicating results to class. (P.I.- 2.1.2, 5.1.2, 5.2.2, 8.2.1, 8.3.1, 9.2.2, 9.3.2)*	
02.	**Syntax Analysis – Top-Down Parsing** ***Learning Objective:*** *Students are expected to apply top-down parsing concept and construct top-down parser using context-free grammars.*	**4-6**
	Contents: Context-Free Grammar, parse trees, ambiguity, left recursion, left factoring, Role of parser, Types of parser, FIRST & FOLLOW, Top down Parser-Recursive descent parsing, Predictive parsing (LL(1)),.	
	Self-Learning Topics: Error recovery strategies.	
	Learning Outcomes: ***A learner will be able to*** ***LO2.1:*** *Apply engineering fundamentals to identify left-factored, and left-recursive grammars and perform left factoring, and remove left recursion of the same (1.4.1)* ***LO2.2:*** *Apply engineering fundamentals to identify ambiguity in grammar by constructing parse tree and eliminate the grammar ambiguity (1.3.1)* ***LO2.3:*** *Identify and analyse the parsing processes, modules, and algorithms required to apply top-down parsing techniques for constructing a parser and verifying whether a given string can be parsed. (2.1.2).* ***LO2.4:*** *Compare and contrast different types of parsers(2.2.4)*	
03.	**Syntax Analysis – Bottom-Up Parsing** ***Learning Objective:*** *Students are expected to apply bottom-up parsing concept and construct bottom-up parser using context-free grammars*	**7-9**

	Contents: Bottom up parser: Shift–reduce parsing, Operator precedence parsing, LR(0), SLR, LALR, Canonical LR parsing , Graph-based parsing, transformer models	
	Self-Learning Topics: Advanced parser error-handling	
	Learning Outcomes: *A learner will be able to* ***LO3.1:*** *Apply engineering fundamentals on bottom-up parsing techniques to construct LR family parsing tables (1.4.1).* ***LO3.2:*** *Identify and analyse the parsing processes, modules, and algorithms required to apply bottom-up parsing techniques for constructing a parser and verifying whether a given string can be parsed. (2.1.2)* ***LO3.3:*** *Apply engineering fundamentals to identify and apply the best AI-based transformer models on a given problem (1.3.1)* ***LO3.4:*** *Compare and contrast different LR strategies on a given problem. (2.2.4).* ***LO3.5:*** *Compare traditional and AI-based parsing models (2.2.4, 11.2.2, 11.3.1).*	
04.	**Intermediate Code Generation**	**7-9**
	Learning Objective: ***Students are expected to produce syntax-directed translation and intermediate representations.***	
	Contents: Intermediate languages, Declarations, assignments, Boolean expressions, case statements, Backpatching, Syntax-directed definitions & translation, Three address code, quadruples, triples, indirect triples, syntax trees	
	Self-Learning Topics:- Intermediate code for loops & arrays	
	Learning Outcomes: *A learner will be able to* ***LO4.1:*** *Identify and analyse the steps and algorithms needed to apply conditional constructs and perform backpatching for a given problem. (2.1.2)* ***LO4.2****: Apply intermediate code generation concepts to design and construct appropriate procedure call representations that meet the functional requirements of a given problem. (3.2.2)* ***LO4.3:*** *Identify and apply suitable syntax-directed translation methods and definitions, using justified assumptions where needed, to construct the SDT tree. (2.2.3)* ***LO4.4****: Demonstrate design alternatives by identifying various intermediate code forms and generating the corresponding three-address codes and syntax trees. (3.2.1)*	
05.	**Code Optimization & Runtime Environment** ***Learning Objective/s:*** *Students are expected to apply optimization techniques and understand runtime memory management..*	**7-9**

	Contents: Need & types of code optimization, Optimization of basic blocks, DAG representation, Data flow analysis, Storage organization, Runtime memory layout, Activation records, non-local access, Parameter passing, Error detection & recovery	
	Self-Learning Topics: LLVM optimization passes	
	Learning Outcomes : *A learner will be able to* ***LO5.1:*** *Identify and apply suitable optimization methods, using justified assumptions where needed, to optimize basic blocks of a given problem using DAGs. (2.2.3)* ***LO5.2:*** *Apply the theoretical principles of runtime environments and activation records to effectively address execution-related requirements in a given code. (1.4.1)* ***LO5.3:*** *Compare and contrast alternative solution/methods to select the best methods for code optimization. (2.2.4)* ***LO5.4:*** *Apply the engineering fundamentals to explore recent development in code optimization(1.3.1, 11.2.2, 11.3.1)*	
06.	**Code Generation** ***Learning Objective:*** *Students are expected to generate efficient target code using code generation strategies*	**5-7**
	Contents: Issues in code generator design, Target machine characteristics, Basic blocks & flow graphs, Next-use information, Register allocation & assignment, Simple code generator, Peephole optimization.	
	Self-Learning Topics: JIT compilation, graph coloring for register allocation ***Learning Outcomes:*** ***LO6.1:*** *Identify issues in the given code and justify approximations and assumptions. (2.2.3)* ***LO6.2:*** *Apply theory and principles of computer science and engineering to solve an engineering problems related to basic blocks and flow graphs (1.4.1)* ***LO6.3:*** *Analyse and compare alternative register allocation techniques and apply the most suitable one to a given problem. (2.2.4)* ***LO6.4:*** *Apply the engineering fundamentals to explore, comprehend & write a technical report on recent trends in code generation (1.3.1, 8.2.1, 8.3.1, 9.2.2, 9.3.2, 11.2.2, 11.3.1)*	
	Course Conclusion The Compiler Design course equips learners with theoretical foundations and practical skills for designing efficient compilers. Students gain strong understanding of lexical, syntax, semantic phases, optimization techniques, and modern approaches such as AI-assisted parsing, enabling them to analyze, design, and develop system-level software	**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
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.
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
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 lexical analysis concepts to identify tokens and develop LEX-based analyzers while explaining compiler phases and effectively communicating results using modern tools.*(LO1.1, LO1.2, LO1.3, LO1.4)*
2. Identify and apply suitable parsing techniques to construct parsers and resolve grammar conflicts. *(LO2.1, LO2.2, LO2.3, LO2.4, LO3.1, LO3.2, LO3.3, LO3.4, LO3.5)*
3. Generate intermediate code using syntax-directed translation and backpatching. *(LO4.1, LO4.2, LO4.3, LO4.4)*
4. Apply optimization techniques and understand runtime memory models. *(LO5.1, LO5.2, LO5.3)*
5. Apply code generation techniques to develop efficient target code by resolving design challenges, and explore emerging trends through technical reporting while demonstrating effective teamwork and communication. *(LO6.1, LO6.2, LO6.3, LO6.4, LO5.4)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CEPEC7044.1	3	3	--	--	3	--	--	3	3	--	--
CEPEC7044.2	3	3	--	--	--	--	--	--	--	--	3
CEPEC7044.3	--	3	3	--	--	--	--	--	--	--	--
CEPEC7044.4	3	3	--	--	--	--	--	--	--	--	--
CEPEC7044.5	3	3	--	--	--	--	--	3	3	--	3
Average	**3**	**3**	**3**	--	**3**	--	--	**3**	**3**	--	**3**

Text Books :

1. Alfred Aho, Monica S Lam, Ravi Sethi, Jeffrey D. Ullman, "*Compilers- Principles Techniques and Tool*", 2nd Edition, Pearson Education India, 2013
2. Jean Paul Tremblay, Paul G Serenson, "The Theory and Practice of Compiler Writing", BS Publications, 2005
3. Dhamdhere, D. M., "Compiler Construction Principles and Practice", 2nd edition, Macmillan India Ltd., New Delhi, 2008

Reference Books :

1. V. Raghavan, "Principles of Compiler Design",1st Edition, McGraw Hill Education,2017.
2. Allen I. Holub, "Compiler Design in C", Prentice Hall of India, 2003
3. C. N. Fischer and R. J. LeBlanc, "Crafting a compiler with C", Benjamin Cummings, 2003
4. Henk Alblas and Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001
5. Kenneth C. Louden, "Compiler Construction: Principles and Practice", Thompson Learning, 2003

Other Resources :

1. https://nptel.ac.in/courses/106105190 Compiler Design, IIT Kharagpur
2. https://www.udemy.com/course/compiler-design-course/?kw=compiler&src=sac&couponCode=CP2511241AG1

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 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
OEC	OEC7011	PRODUCT LIFE CYCLE MANAGEMENT	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. PO3 : Design / Development of Solutions
2. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Introduction to Product Lifecycle Management (PLM)**	**09-11**
	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications, PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	
02.	**Product Design**	**09-11**
	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase,	

	Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
03.	**Product Data Management (PDM)**	**05-07**
	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
04.	**Virtual Product Development Tools**	**05-07**
	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05.	**Integration of Environmental Aspects in Product Design**	**05-07**
	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06.	**Life Cycle Assessment and Life Cycle Cost Analysis**	**04-06**
	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7011.1	--	--	-	--	--	3	--	--	--	3	--
OEC7011.2	--	--	3	--	--	--	--	--	--	3	--
OEC7011.3	--	--	3	--	--	--	--	--	--	--	--
OEC7011.4	--	--	3	--	--	--	--	--	--	3	--
Average	--	--	**3**	--	--	**3**	--	--	--	**3**	--

References :

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC7012	RELIABILITY ENGINEERING	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. PO 4: Conduct investigations of complex problems
5. PO 5: Engineering Tool Usage

Course Objectives:

1. To familiarize the students with various aspects of probability theory.
2. To acquaint the students with reliability and its concepts.
3. To introduce the students to methods of estimating the system reliability of simple and complex systems.
4. To understand the various aspects of Maintainability, Availability and FMEA procedure.

Module	Details	Hrs.
00.	**Course Introduction** Reliability Engineering is a vital discipline within engineering that focuses on ensuring systems and components perform their intended functions consistently over their expected lifetime. The course introduces students to the principles, tools, and methodologies used to analyze, predict, and improve the reliability of engineering systems. Students will explore key concepts such as failure mechanisms, probability models, reliability metrics, system configurations, maintenance strategies, and life data analysis. Through theoretical understanding and practical applications, the course aims to develop the ability to design reliable products, evaluate system performance, and implement reliability improvement programs in real-world engineering environments. By the end of the course, learners will gain a strong foundation in reliability concepts and become capable of applying these principles across various domains including mechanical, electrical, electronic, and manufacturing systems.	**01**

01.	**Contents:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Rules for combining probabilities, independent, mutually exclusive, complimentary, conditional events, simultaneous occurrence of events.	**05-07**
02.	**Reliability Concepts** **Contents:** Reliability definitions, Reliability functions, Importance of Reliability, Quality Assurance and Reliability. Failure- causes of failures, modes of failures, Bath Tub Curve Failure Data Analysis: Failure density, Mean Time to Failure (MTTF), Mean time between failure (MTBF).	**07-09**
03.	**Reliability Hazard Models** **Contents:** Hazard rate, Constant Hazard, Hazard Models –Constant Failure Rate, linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution MTTF in terms of failure Density, Mean time in failure in integral form functions and reliability analysis.	**06-08**
04.	**System Reliability** **Contents:** System Configurations: Series, parallel, mixed configuration, k- out of n structure, Complex systems. Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	**05-07**
05.	**Maintainability and Availability** **Contents:** Maintainability, System Down time, Reliability and Maintainability tradeoff. Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability– qualitative aspects, Availability measures	**07-09**
06.	**Failure Mode, Effects & Criticality Analysis and Fault Tree Analysis** **Contents:** Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, Fau1t tree analysis and Event Tree Analysis. Fault Tree Analysis, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event Tree Analysis.	**07-09**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply the concept of Probability theory to engineering problems.
2. Understand fundamental concept of reliability to calculate different reliability parameters.
3. Differentiate between reliability hazard models.

4. Illustrate the understanding of System Reliability.
5. Illustrate the various aspects of Maintainability and Availability
6. Familiarize with the FMECA and able to construct fault tree diagrams.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7012.1	3	3	--	--	--	--	--	--	--	--	--
OEC7012.2	3	3	--	--	3	--	--	--	--	--	--
OEC7012.3	3	3	--	3	--	--	--	--	--	--	--
OEC7012.4	3	3	3	3	--	--	--	--	--	--	--
OEC7012.5	3	3	3	--	--	--	--	--	--	--	--
OEC7012.6	3	3	3	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**3**	**3**	--	--	--	--	--	--

Text Books :

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. E. Balagurusamy, “Reliability Engineering”, Mcgraw Hill Education (India), 2003.

Reference Books :

1. P.D.T. Conor, “Practical Reliability Engineering”, John Wiley & Sons, 1985.
2. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.3
3. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Other Resources :

1. Introduction to Reliability Engineering
   Link - https://nptel.ac.in/courses/127105234

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 Marks)

Suggested breakup of distribution

Class Test	:	05 Marks
MCQ test as per GATE exam pattern / level	:	05 Marks
Open book Test	:	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
OEC	OEC7013	MANAGEMENT INFORMATION SYSTEM	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. PO6 : The engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Introduction To Information Systems (IS)**	**03-05**
	Contents: Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	
02.	**Data and Knowledge Management**	**07-09**
	Contents: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	
03.	**Ethical issues and Privacy**	**07-09**
	Contents:	

	Information Security. Threat to IS, and Security Controls	
04.	**Social Computing (SC)**	**07-09**
	Contents: Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
05.	**Computer Networks**	**06-08**
	Contents: Wired and Wireless technology, Pervasive computing, Cloud computing model	
06.	**Information System within Organization**	**07-09**
	Contents: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Explain how information systems Transform Business.
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7013.1	3	--	--	--	--	3	--	--	--	--	--
OEC7013.2	3	--	--	--	--	3	--	--	--	--	--
OEC7013.3	3	--	--	--	--	--	--	--	--	--	--
OEC7013.4	3	--	--	--	--	--	--	--	--	3	--
OEC7013.5	3	--	--	--	--	--	--	--	--	3	--
Average	**3**	--	--	--	--	3	--	--	--	3	--

References :

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7014	DESIGN OF EXPERIMENTS	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 : Conduct Investigations of Complex Problems
4. PO5 : Engineering Tool Usage

Course Objectives :

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Introduction**	**05-07**
	Contents: Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology	
02.	**Fitting Regression Models**	**08-10**
	Contents: Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit	
03.	**Two-Level Factorial Designs** **Contents:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs	**07-09**

04.	**Two-Level Fractional Factorial Designs** **Contents:** The One-Half Fraction of the 2k Design, The One-Quarter Fraction of the 2 k Design, The General 2k-p Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs	**07-09**
05.	**Response Surface Methods and Designs** **Contents:** Introduction to Response Surface Methodology , The Method of Steepest Ascent, Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces	**07-09**
06.	**Taguchi Approach** **Contents:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples	**03-05**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7014.1	3	3	--	3	--	--	--	--	--	--	--
OEC7014.2	3	3	--	--	3	--	--	--	--	--	--
OEC7014.3	3	-	--	3	3	--	--	--	--	--	--
Average	**3**	**3**	--	**3**	**3**	--	--	--	--	--	--

References :

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3 rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley

4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2

5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7015	OPERATION RESEARCH	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: 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. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the concept of formulation of a real-world problem as a mathematical programming model.
2. To impart the knowledge of the mathematical tools that are needed to solve optimization problems.
3. To make learner able to use mathematical software to solve the proposed models.
4. To impart the mathematical understanding to analyse and solve integer programming from a wide range of applications.

Module	Detailed Contents	Hrs
00.	**Course Introduction** Operations Research (OR) course is an interdisciplinary field that applies advanced analytical, mathematical, and statistical methods to make better decisions in complex systems, optimizing processes and resource allocation. Students learn to identify problems, formulate mathematical models like linear programming, and use algorithms to find optimal solutions for real-world issues in areas such as engineering, management, finance, and logistics.	01
01.	**Introduction to Operations Research** **Content:** Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming:** Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method, Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness	15-17

	Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem:** Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02.	**Queuing models** **Contents:** Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population.	**04-06**
03.	**Simulation** **Contents:** Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	**06-08**
04.	**Dynamic programming** **Contents:** Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	**06-08**
05.	**Game Theory** **Contents:** Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	**04-06**
06.	**Inventory Models** **Contents:** Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model	**04-06**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Apply simplex method, analyse the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change
3. Solve specialized linear programming problems like the transportation and assignment problems.
4. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
5. Analyse the applications of integer programming and a queuing model and compute important performance measures

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7015.1	3	3	3	--	--	--	--	--	--	--	--
OEC7015.2	3	3	--	--	--	--	--	--	--	--	--
OEC7015.3	3	3	3	--	--	3	--	--	--	3	3
OEC7015.4	3	3	3	--	--	3	--	--	--	3	3
OEC7015.5	3	3	3	--	--	3	--	--	--	--	3
Average	**3**	**3**	**3**	--	--	**3**	--	--	--	**3**	**3**

Text Books :

1. Operations Research - An Introduction, Taha, H.A., Seventh Edition 2002, Prentice Hall.
2. Operations Research, S. D. Sharma, First Edition, 2012, KedarNath Ram Nath-Meerut Company
3. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Twentieth Edition, 2022 Sultan Chand & Sons

Reference Books :

1. Operation Research-Methods and problems, Saiesini M.,Yaspan A., First Edition, 1959, Prentice Hall
2. Operations Research: Principles and Practice, Ravindran, A, Phillips, D. T and Solberg, J. J., Second edition, 2009, John Willey and Sons.
3. Introduction to Operations Research, Hiller, F. S. and Liebermann, G. J., Fourth edition, 2002, Tata McGraw Hill

Other Resources :

1. NPTEL Course: Introduction to Operation Research, Prof. G.Srinivasa, IIT Madras
   Web Link- https:// nptel.ac.in/courses/110106062
2. NPTEL Course: Operations Research, Prof. Kusum Deep, IIT Roorkee

Web Link- https://onlinecourses.nptel.ac.in/noc22_ma48/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC7016	CYBER SECURITY AND LAWS	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. PO 1: Engineering knowledge
2. PO 2: Problem analysis
3. PO 3: Design and Development of Solution
4. PO 4: Conduct investigation of Complex Problem
5. PO 5: Engineering Tool Usage
6. PO 11: Life-long learning

Course Objectives:

1. To define and categorize various forms of cybercrime, including malware attacks, social engineering, financial fraud, and network intrusions, while understanding their technical and societal impacts.
2. To analyse the legal frameworks governing cyber activities, with a focus on distinguishing between different types of cyber laws at national and international levels.
3. To examine the key provisions and structure of the Indian IT Act, 2008, and to evaluate the implications of its latest amendments on digital governance, privacy, and cybercrime adjudication.
4. To identify and compare global information security standards and compliance frameworks, such as ISO 27001, PCI-DSS, GDPR, HIPAA, and NIST, and their relevance to organizational security postures.
5. To apply legal and compliance knowledge in practical scenarios, enabling students to assess organizational compliance requirements and recommend appropriate security controls within legal boundaries.

Module	Details	Hrs.
00.	**Course Introduction** This course provides a comprehensive introduction to the principles, practices, and legal frameworks of cyber security. Students will explore various types of cybercrimes, attack methodologies, and defensive strategies, with a strong emphasis on legal and regulatory compliance. The course covers Indian cyber laws and compliances, including the IT Act 2000 and its amendments, as well as global security standards. Through theoretical insights, learners will be equipped to identify, analyse, and respond to cyber threats within a legal and ethical context.	**01**
01.	**Introduction to Cybercrime** **Contents:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	**05-06**
02.	**Cyber offenses & Cybercrime** **Contents:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	**07-08**
03.	**Tools and Methods Used in Cyberspace** **Contents:** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	**07-08**
04	**The Concept of Cyberspace** **Contents:** The Concept of Cyberspace, E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange, Law Relating to Electronic Banking, The Need for an Indian Cyber Law.	**07-08**
05	**Indian IT Act** **Contents:** Cyber Crime and Criminal Justice, Penalties under the IT Act, 2000, Adjudication Mechanism, Appeals under the IT Act, Information Technology Act, 2000, IT Act, 2008 and its Amendments.	**05-06**
06	**Information Security Standard compliances** **Contents:** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	**04-05**

	Course Conclusion This course equips learners with essential knowledge of cybercrime, cybersecurity practices, and cyber laws governing the digital ecosystem. Students gain an understanding of the Indian IT Act and its amendments, various aspects of cyber law, cybercrime investigation and adjudication processes, and major information security compliance standards. Overall, the course enables learners to analyze cyber threats, interpret legal and regulatory requirements, and apply security and compliance principles for secure and lawful use of information systems.	**01**
	Total	**45**

Course Outcomes: A learner will be able to –

1. Classify various types of cybercrimes, cyber threats, and attack techniques, and analyze their technical and societal impacts in digital environments.
2. Analyze cyberattack scenarios and security challenges to identify vulnerabilities, attack vectors, and appropriate technical and organizational security measures.
3. Interpret and apply provisions of the Indian Information Technology Act, 2000 and its amendments to address cybercrime investigation, adjudication, and legal issues.
4. Analyze different aspects of cyber law, including cyberspace governance, e-commerce, digital contracts, intellectual property, electronic evidence, and criminal liability.
5. Apply cybersecurity, legal, and compliance knowledge to real-world scenarios to recommend lawful, secure, and compliant practices in the design and use of information systems.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7016.1	3	-	-	-	-	--	--	--	--	--	--
OEC7016.2	3	3	3	3	3	--	--	--	--	--	3
OEC7016.3	3	3	--	--	--	--	--	--	--	--	--
OEC7016.4	3	3	--	--	--	--	--	--	--	--	--
OEC7016.5	3	3	--	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**3**	**3**	--	--	--	--	--	**3**

Text Books:

1. Nina Godbole, Sunit Belapure, “Cyber Security”, Wiley India, New Delhi.
2. “The Indian Cyber Law” by Suresh T. Vishwanathan; Bharat Law House New Delhi.
3. “The Information technology Act, 2000”; Bare Act- Professional Book Publishers, New Delhi.

Reference Books:

1. "Cyber Law & Cyber Crimes" By Advocate Prashant Mali; Snow White Publications, Mumbai.
2. William Stallings, "Cryptography and Network Security", Pearson Publication.
3. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.

Other Resources:

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

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 Open Book Test: 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
OEC	OEC7017	DIGITAL BUSINESS MANAGEMENT	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 Solution
4. PO5: Modern tool Usage
5. PO7: Ethics

Course Objectives:

1. To familiarize students with fundamental concepts, models, and transformation drivers that define digital business ecosystems.
2. To convey strategic frameworks, digital roadmaps, organizational readiness, and performance metrics used in digital transformation.
3. To explain key digital marketing techniques, customer acquisition methods, automation tools, and attribution models.
4. To provide understanding of ecommerce and Omni channel operations, including platforms, logistics, payments, and customer service systems.
5. To develop competency in data-driven decision-making, analytics tools, dashboards, SQL basics, and AI applications in business.
6. To familiarize with platform business models, API integrations, agile/lean product development, and ethical, legal, and security considerations in digital environments.

Module	Details	Hrs.
00.	**Course Introduction** Digital Business Management focuses on how digital technologies transform traditional business systems, processes, and decision-making. This course introduces foundations of digital business, digital strategy, marketing, ecommerce, data analytics, platforms, and product delivery, emphasizing the differences between traditional and digital business models. With growing reliance on cloud platforms, analytics, AI, and Omni channel systems, engineering graduates must understand how	**01**

	technical solutions enable digital transformation and value creation. The course equips with managerial and analytical perspectives required to design, evaluate, and manage technology driven business solutions in modern digital enterprises.	
01.	**Foundations of Digital Business**	**06-08**
	Contents: Introduction to Digital Business: Definition and scope Key terminology: digitization, digitalization, transformation Traditional vs Digital Business Models Digital Transformation Drivers Digital Maturity & Culture Digital Business Models – Marketplaces, Subscription, Freemium, PaaS, Value Chains Network Effects & Customer Experience	
02.	**Digital Strategy & Transformation**	**06-08**
	Contents: Strategy Frameworks for Digital Initiatives Organizational Change & Governance Digital Roadmap Development Digital Leadership skills: innovation, risk-taking, cross-functional alignment Metrics for Digital Success (Engagement, Retention, Lifetime Value, Customer Acquisition Cost) KPI Dash boarding & Review	
03.	**Digital Marketing & Customer Acquisition**	**06-08**
	Contents: Digital Marketing Fundamentals Search Engine Optimization & Search Engine Marketing Basics Social Media & Influencer Marketing Content Marketing & Campaign Design Customer Journey Mapping Personalization & CRM Tools Attribution Models & Optimization Campaign optimization: A/B testing basics	
04.	**Ecommerce & Omni channel Operations**	**06-08**
	Contents: Ecommerce Models (B2B, B2C, C2C, D2C) Payments, Fulfilment, Returns, Last-mile Logistics Omni channel Commerce Inventory Visibility & Order Management Digital Customer Service Tools Platform Selection & vendor Evaluation	
05.	**Data, Analytics & AI for Business**	**07-09**
	Contents: Data-driven Decision Making Data Pipelines & SQL Basics Descriptive & Diagnostic Analytics Predictive Analytics	

	Recommendation Engines KPI Dashboards (Tools) Communicating Data Insights	
06.	**Platforms, Ecosystems, Product Delivery & Ethics**	**06-08**
	Contents: Platform Business Models & Ecosystems Product Management Basics Agile & Lean Startup API Economy & Partnerships Ethical, Legal & Security Considerations	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: A learner will be able to -

1. Summarize the fundamental concepts, models, transformation drivers and customer experience elements of digital business.
2. Analyse the digital strategies, organizational reediness, transformation plans & business performance metrics to evaluate digital initiatives.
3. Apply digital marketing, customer acquisition methods, automation tools, and attribution techniques to develop data driven marketing insights.
4. Classify ecommerce and omnichannel models, evaluate digital platform, and analyse operational workflow to propose process improvements.
5. Use analytical tools, dashboards, SQL fundamental and AI concepts to interpret business data and communicate insights effectively.
6. Analyse platform ecosystem, select product development methodologies, interpret API based integrations and identify ethical/ legal concerns in digital system.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7017.1	3	3	--	--	--	--	--	--	--	--	--
OEC7017.2	3	3	3	--	--	--	--	--	--	--	--
OEC7017.3	--	3	3	--	--	--	--	--	--	--	--
OEC7017.4	--	3	--	--	--	--	--	--	--	--	--
OEC7017.5	--	3	--	--	3	--	--	--	--	--	--
OEC7017.6	--	3	--	--	--	--	--	--	--	--	--
Average	**3**	**3**	**3**	**-**	**3**	**-**	**3**	**-**	**-**	**-**	**-**

Text Books :

1. K. C. Laudon and J. P. Laudon, Management Information Systems: Managing the Digital Firm, latest ed. Harlow, U.K.: Pearson Education.
3. D. L. Rogers, The Digital Transformation Playbook: Rethink Your Business for the Digital Age, New York, NY, USA: Columbia Business School Publishing, 2016.
   K. Sandeep & J. J. Jose, Digital Business Management, Himalaya Publishing House.
4. A. Osterwalder and Y. Pigneur, Business Model Generation, Hoboken, NJ, USA: Wiley, 2010.
5. E. Brynjolfsson and A. McAfee, The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, New York, NY, USA: W. W. Norton & Company, 2014.
6. P. Kotler, H. Kartajaya, and I. Setiawan, Marketing 5.0: Technology for Humanity, Hoboken, NJ, USA: Wiley, 2021.

Reference Books :

1. T. Eisenmann, G. Parker, and M. Van Alstyne, Platform Revolution: How Networked Markets Are Transforming the Economy, New York, NY, USA: W. W. Norton & Company, 2016.
   R. T. Rust, M.-H. Huang, and S. J. Lin, Service Analytics and Digital Transformation, Springer,
2. Cham, Switzerland, 2019.
   S. Sharda, D. Delen, and E. Turban, Business Intelligence, Analytics, and Data Science: A
3. Managerial Perspective, 4th ed. Boston, MA, USA: Pearson, 2020.
   M. Porter and J. Heppelmann, How Smart, Connected Products Are Transforming Companies,
4. Boston, MA, USA: Harvard Business Review Press, 2015.
   A. Chaffey and F. Ellis-Chadwick, Digital Marketing: Strategy, Implementation and Practice,
5. 8th ed. Harlow, U.K.: Pearson Education, 2022.

Other Resources :

1. Digital Business – IIT Kharagpur (Prof. S. Ray) NPTEL Course – Highly aligned with Digital Strategy, Platforms, Digital Models.

2. Marketing Management – IIT Roorkee / IIT Kanpur (Digital marketing modules included) Covers customer journey, campaigns, analytics basics.

3. Introduction to Industry 4.0 and Industrial Internet of Things – IIT Kharagpur Useful for Module 1 (Digital Transformation Drivers).

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory-(20 Marks)

Suggested break up of distribution:

a) Activities/Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (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
OEC	OEC7018	ENERGY AUDIT AND MANAGEMENT	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: NIL

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem analysis
3. PO4: Conduct investigations of complex problems
4. PO6: The Engineer and The World
5. PO11: Life-long learning

Course Objectives:

1. To understand the importance of energy security in achieving sustainable development and to learn the fundamental principles of energy conservation.
2. To introduce performance evaluation criteria for electrical and thermal installations to support effective energy management.
3. To utilize data obtained from performance evaluations to identify and prioritize energy-saving measures.

Module	Details	Hrs.
00.	**Course Introduction** Energy is a critical resource for economic growth, industrial productivity, and sustainable development. With rising energy costs, increasing demand, and growing environmental concerns, efficient use of energy has become essential across all sectors. Energy Audit and Management focuses on the systematic evaluation, monitoring, and optimization of energy consumption to improve efficiency, reduce operating costs, and minimize environmental impact. This course introduces the principles and practices of energy management, including energy auditing techniques, energy efficiency measures, and the use of modern tools for energy analysis. Students will learn how to assess energy usage in industrial, commercial, and residential facilities, identify energy-saving opportunities.	01
01.	**Energy Scenario** **Contents:** Primary and Secondary Commercial and non- commercial energy Renewable and Non Renewable Energy, Present Global and Indian Energy Scenario, Energy Security, Energy Conservation and its	05-07

	Importance, Energy efficiency benefits. Energy Conservation Act-2001 and its Features. Schemes of BEE under EC Act-2001.	
02.	**Energy Audit Principles:**	**08-10**
	Contents: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments. Elements of monitoring& targeting, benefits of M&T; Data and information-analysis. Investment need, Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	
03.	**Energy Management and Energy Conservation in Electrical System:**	**09-11**
	Contents: Basics of Electrical Energy, power factor, Motor loading calculations, relationship between power, voltage and current. Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, harmonics. Energy efficiency measures in lighting system, lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers, General energy saving opportunities in lighting system, Energy conservation opportunities in induction motors, Energy efficient motors, Motor retrofitting, soft starters, variable speed drives. Case studies based on P.F improvement, EEM, Lighting system	
04.	**Energy Management and Energy Conservation in Thermal Systems:**	**09-11**
	Contents: Thermal Energy basics, specific heat, sensible heat, latent heat, energy content in fuel, Heat transfer basics Energy unit and conversions. Review of different thermal loads: Boiler System, performance evaluation of boilers, energy conservation opportunities in boiler Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, efficient steam utilization and energy saving opportunities. Characteristics of efficient furnace, performance evaluation of a typical fuel fired furnace, general fuel economy measures in furnaces Need and benefits of insulation, simplified formula for heat loss calculation, Purpose of heat exchanger, LMTD HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and energy savings opportunities.	

	Case Studies based on boiler, furnace and insulation	
05.	**Energy Performance Assessment:**	**03-05**
	Contents: On site Performance evaluation techniques, Energy performance assessment and its improvement: lighting system, Installed Load Efficacy Ratio (ILER) method, Motor, Heat Exchanger-LMTD, Boiler and Furnace.	
06.	**Energy conservation in Buildings:**	**03-05**
	Contents: Energy Conservation Building Codes (ECBC), ECBC guidelines on HVAC system, lighting system, Electric power, energy efficiency measures in buildings, Energy performance assessment of buildings, Green Building.	
	Course Conclusion This course provides a comprehensive understanding of energy auditing principles and energy management practices. Learners gain knowledge of energy consumption patterns, audit methodologies, and energy performance evaluation techniques for electrical and thermal utilities. The course emphasizes the identification of energy conservation opportunities, and implementation of energy-efficient technologies.	**01**
	Total	**45**

Course Outcomes :

1. Understand global and Indian energy scenario, Energy Conservation Act-2001, ECBC guidelines, to promote energy-efficient and sustainable buildings.
2. Conduct energy audits, analyse energy performance, identify energy-saving opportunities, and evaluate the financial feasibility of energy conservation measures.
3. Apply energy efficiency measures in lighting and motor systems, improve power factor, and identify practical energy conservation opportunities through case studies.
4. Apply energy-saving opportunities in boilers, furnaces, steam distribution, insulation, and HVAC systems, and practical solutions through case studies to improve energy efficiency.
5. Analyse the energy performance of lighting, motors, boilers, furnaces, and heat exchangers on-site and recommend effective energy-saving improvements.

CO-PO mapping table with correlation level:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7018.1	3	--	--	--	--	3	--	--	--	--	--
OEC7018.2	3	3	--	3	--	3	--	--	--	--	3
OEC7018.3	3	--	--	--	--	--	--	--	--	--	--
OEC7018.4	3	--	--	--	--	--	--	--	--	--	--
OEC7018.5	--	3	--	--	--	3	--	--	--	--	3
Average	**3**	**3**	**--**	**3**	**--**	**3**	**--**	**--**	**--**	**--**	**3**

Text Books:

1. General Aspects of Energy Management and Energy Audit, BEE, Fourth Edition,2015
2. Energy Efficiency in Thermal Utilities, BEE, Fourth Edition,2015
3. Energy Efficiency in Electrical Utilities, BEE, Fourth Edition,2015
4. Energy Performance Assessment for Equipment and Utility Systems, BEE, Fourth Edition,2015

Reference Books:

1. Handbook of Electrical Installation Practice, by Geoffrey Stokes, Blackwell Science, 4th Edition
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Web References:

1. http://www.bee-india.nic.in/
2. https://nceexam.in/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. **Continuous Assessment (20 Marks)**
   - 01 MCQ test: 05 Marks
   - 01 Class test: 10 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
OEC	OEC7019	DEVELOPMENT ENGINEERING	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. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO11: Life-long learning

Course Objectives :

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Module	Details	Hrs
00.	**Course Introduction**	**01**
01.	**Introduction to Rural Development**	**08-10**
	Contents: Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
02.	**Post-Independence rural Development**	**04-06**
	Contents: Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	

03.	**Rural Development Initiatives in Five Year Plans** **Contents:** Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	**06-08**
04.	**Post 73rd Amendment Scenario** **Contents:** 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	**04-06**
05.	**Values and Science and Technology** **Contents:** Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	**10-12**
06.	**Ethics** **Contents:** Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**03-05**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC7019.1	--	--	--	--	--	3	--	--	--	--	--
OEC7019.2	--	--	--	--	--	3	--	--	--	--	--
OEC7019.3	--	--	--	--	--	3	--	--	--	--	--
OEC7019.4	--	--	--	--	--	3	--	--	--	--	3
OEC7019.5	--	--	--	--	--	3	3	--	--	--	--
OEC7019.6	--	--	--	--	--	3	3	--	--	--	3
Average	--	--	--	--	--	**3**	**3**	--	--	--	**3**

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment – Theory (20 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	Credit
LBC	CELBC710	COMPUTATIONAL INTELLIGENCE LABORATORY	01

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

Pre-requisite:

CESBL301 Python Programming

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Modern tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO11: Life-long learning

Course Objectives:

1. Formulate real-world problems as knowledge-driven and decision-oriented tasks to model intelligent system.
2. Design, implement, and evaluate classical machine learning pipelines.
3. Design and interpret deep neural network models for perception, feature representation, and complex pattern learning.
4. Integrate Machine Learning, Deep Learning, and Artificial Intelligence components into a complete end-to-end explainable intelligent system for real-world applications.

Modul	Detailed Contents	Hrs
	Course Introduction This laboratory enables students to understand the complete life-cycle of intelligent system development, from data acquisition and learning to reasoning and decision-making. It equips students with the skills to design, implement, and evaluate end-to-end intelligent systems by integrating Machine Learning, Deep Learning, and Artificial Intelligence, thereby preparing them to excel in the rapidly evolving field of computational intelligence.	
01.	**Intelligent Knowledge and Decision Systems:** ***Learning Objective:*** *To enable students to model real-world problems, design rule-based systems with appropriate inference mechanisms, and validate as well as interpret explainable AI decisions using test scenarios.*	**8**

Contents:

- Knowledge representation
- Design of rule-based systems
- Inference mechanisms
- Explainable decision logic
- State-space representation of problems
- Classical search strategies
- Validation of AI decisions using test scenarios
- Interpretation and explanation of system decisions

Task 1: Select a real-world problem statement and define its scope. Identify the fundamental entities, their associated attributes, the relationships among the entities, and the governing constraints of the problem. Choose a suitable knowledge representation method (logical representation, frames, semantic networks, or ontology) based on the nature of the problem. Finally, create the formal structured knowledge model using the selected representation technique and validate it using sample inputs.

Learning Outcome:
A learner will be able to
LO 1.1: Analyze a real-world problem by identifying key entities, attributes, relationships, and constraints; select an appropriate knowledge representation method such as logic, frames, semantic networks, or ontologies; and construct a structured and consistent knowledge model that accurately captures domain semantics.(P.I. – 2.1.1, 2.1.2, 2.3.1, 5.1.1)

Task 2: Define the decision-making logic of the selected problem by formulating a set of IF–THEN rules based on the identified knowledge. Choose an appropriate inference mechanism(forward chaining or backward chaining), depending on the nature of decision flow. Implement the rule engine using a suitable tool. Test the system using multiple sample inputs to verify correct rule firing and inference behavior.

Learning Outcome:
A learner will be able to
LO 1.2 : Design a rule-based decision system by formulating IF–THEN rules, selecting an inference mechanism such as forward or backward chaining, implementing the reasoning engine, and analyzing the generated decision paths for correctness and explainability. (P.I. – 2.2.1, 3.4.2, 4.3.4, 5.2.2)

Task 3: Model the selected problem in the form of a state-space representation by defining the initial state, goal state, allowable actions, and state transitions. Implement uninformed search algorithms(Breadth First Search (BFS) and Depth First Search (DFS)). Next, apply a heuristic-based search technique(A* or Greedy Best-First Search) by defining an appropriate heuristic function. Compare the obtained solution paths based on path cost, time complexity, and optimality.

Learning Outcome:
A learner will be able to
LO 1.3 :Model a given problem as a state space by defining states, actions, and transitions; implement uninformed and heuristic search strategies such as BFS, DFS, and A; compare solution paths based on optimality and efficiency; and interpret the obtained planning behavior.(P.I. – 2.3.1, 3.3.1, 4.3.1, 5.2.1)*

02.	**Data-Driven Predictive Modelling** ***Learning Objective:*** *To enable students to preprocess data, engineer features, and build and evaluate classical machine learning models for effective prediction.*	**8**
	Contents: • Exploratory Data Analysis (EDA) • Feature Engineering Techniques • Supervised Learning: Linear Regression, Decision Trees, SVM, Ensemble Learning • Unsupervised Learning: Partition and Hierarchical Clustering • Performance evaluation of ML models **Task 4:** Load a real-world dataset relevant to the selected problem in formats such as CSV, Excel, or JSON. Perform initial data exploration by examining the dataset structure, feature types, data distributions, and summary statistics. Apply appropriate data preprocessing techniques(handling missing values, removing duplicates, detecting outliers, and normalizing or scaling features). Use suitable visualization tools to identify data patterns and trends. Prepare a cleaned dataset for further modeling. ***Learning Outcome:*** *A learner will be able to* *LO 2.1 : Load real-world datasets using suitable tools; inspect structure, feature types, and distributions; detect issues such as missing values, anomalies, and inconsistencies; and apply initial transformations to ensure data correctness and readiness for modeling.(P.I. – 2.1.2, 5.1.1, 5.2.2)* **Task 5:** Perform feature extraction, transformation, and encoding to convert raw data into a machine-learning-ready format. Apply feature selection techniques to identify the most relevant features contributing to prediction. Analyze feature importance using appropriate statistical or model-based methods. Split the processed dataset into training and testing sets using suitable partition ratios. Prepare the final feature matrix for model training. ***Learning Outcome:*** *A learner will be able to* *LO 2.2 : Apply preprocessing methods such as cleaning, encoding, scaling, or normalization; extract and transform relevant features; perform feature selection using statistical or model-based approaches; and prepare final input datasets suitable for training machine learning models.(P.I. – 2.2.3, 2.4.1, 3.3.1, 4.1.2, 5.1.2)* **Task 6:** Prepare the final feature matrix for model training.Select appropriate machine learning algorithms (supervised, un-supervised).Train the selected models using the prepared training dataset. Evaluate model performance using suitable evaluation metrics such as accuracy, precision, recall, F1-score, and confusion matrix. Perform error and misclassification analysis to understand model limitations. ***Learning Outcome:*** *A learner will be able to* *LO 2.3 : Select appropriate learning algorithms; train models using prepared datasets; evaluate performance using metrics , and interpret the results to identify model strengths and limitations.(P.I. – 2.4.2, 3.4.3, 4.3.1, 5.2.2)*	

03.	**Deep Representation & Learning Systems** ***Learning Objective:*** *To enable students to design, train, optimize, and interpret deep neural network models for representation and prediction tasks.*	8
	Contents: • Introduction to Neural Networks • Convolutional Neural Networks (CNNs) for Image Processing tasks • Model Evaluation techniques and Hyperparameter Tuning **Task 7:** Design and implement an advanced deep learning architecture(Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), or Long Short-Term Memory (LSTM)) based on the data type. Train the model using appropriate hyperparameters and regularization techniques. ***Learning Outcome:*** *A learner will be able to* *LO 3.1 : Develop advanced deep learning models such as CNNs, RNNs, or LSTMs; optimize them using regularization or tuning strategies.(P.I. – 3.2.2, 3.4.2, 4.1.2, 5.2.2, 7.1.1, 11.2.2)* **Task 8:** Apply interpretability and visualization methods(feature maps, activation visualization, or attention mechanisms). Compare the performance and interpretability with the basic model. ***Learning Outcome:*** *A learner will be able to* *LO 3.2: Apply interpretability techniques such as feature maps or activation visualization; and evaluate transparency and reliability of model predictions.(P.I. – 4.3.3, 5.1.2, 7.2.2, 11.2.1)*	
04.	**Integrated Intelligent Systems & Deployment** ***Learning Objective:*** *To enable learners to integrate AI reasoning with ML and DL models to build, validate, and present an explainable end-to-end intelligent system.*	**6**
	Contents: • Design of end-to-end system architecture integrating:Deep Learning (for feature representation), Machine Learning (for prediction), and Artificial Intelligence (for decision-making) • System-level validation and performance testing • Ethical, legal, and bias considerations in intelligent systems **Task 9**: Design and implement an end-to-end intelligent system pipeline by integrating Deep Learning,Machine Learning, and Artificial Intelligence for decision making. ***Learning Outcome:*** *A learner will be able to* *LO 4.1 : Integrate AI reasoning modules with machine learning and deep learning components; establish data flow among all subsystems; test the unified pipeline using representative inputs; and evaluate end-to-end decision behavior for correctness and consistency.(P.I. – 3.3.1, 3.4.2, 6.2.1 6.3.2)*	

	Task 10: Validate the integrated intelligent system using unseen test inputs and evaluate its overall performance. Analyze the explainability of system decisions using model interpretation techniques. Identify and discuss ethical, fairness, and bias-related issues in system behavior. ***Learning Outcome:*** *A learner will be able to* *LO 4.2 : Deploy the integrated intelligent system using suitable tools; document system architecture, methodology, results, and decisions; prepare a structured presentation; and demonstrate ethical awareness related to fairness, safety, and responsible AI practices.(P.I. – 6.2.1, 7.1.1, 7.2.2, 11.1.2, 11.2.2)*	
	Course Conclusion: After successful completion of this laboratory course, students will be able to understand and apply the fundamental concepts of Artificial Intelligence, Machine Learning, and Deep Learning; analyze real-world problems and develop appropriate intelligent solutions; implement, test, and evaluate learning-based models and decision-making systems; integrate different computational intelligence techniques into a working solution for real-world applications; and demonstrate ethical awareness.	
	Total Hours	**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
2.2.1	Reframe the computer-based system into interconnected subsystems
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.
2.4.1	Apply engineering mathematics / principles to solve a problem
2.4.2	Analyze and interpret the results using contemporary tools.
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.
3.4.2	Able to implement and integrate the modules.
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.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
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.
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 such as computer aided drafting, modeling and analysis; 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.

5.2.2 Demonstrate proficiency in using discipline-specific tools

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

6.3.2 Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.

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

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

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

Course Outcomes (COs): Learner will be able to:

1. **Analyze** real-world problems and develop explainable decision-making systems by constructing formal knowledge representations and implementing rule-based reasoning and inference mechanisms using appropriate Artificial Intelligence techniques. (Mapped LOs: 1.1, 1.2, 1.3)
2. **Acquire, preprocess, and transform** real-world data and **develop** predictive machine learning models by applying appropriate feature engineering, model training, and performance evaluation techniques.*(Mapped LOs: 2.1, 2.2, 2.3)*
3. D**esign, train, optimize, and interpret deep learning models** using suitable neural network architectures and explainability techniques for representation learning tasks.*(Mapped LOs: 3.1, 3.2)*
4. **Integrate Artificial Intelligence reasoning with Machine Learning and Deep Learning models** to build an end-to-end intelligent system, and demonstrate system deployment, documentation, presentation, and ethical responsibility.*(Mapped LOs: 4.1, 4.2)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELBC710.1	-	3	3	3	3	-	-	-	-	-	
CELBC710.2	-	3	3	3	3	-	-	-	-	-	
CELBC710.3	-	-	3	3	3	-	3	-	-	-	3
CELBC710.4	-	-	3	-	-	3	3	-	-	-	3
Average	-	3	3	3	3	3	3	-	-	-	3

Text Books :

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, ISBN: 978-0134610993, 4th Edition, 2020.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, ISBN: 978-0387310732, 1st Edition, 2006.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press, ISBN: 978-0262035613, 1st Edition, 2016.
4. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly, ISBN: 978-1492032649, 2nd Edition, 2019.

Reference Books:

1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson, ISBN: 978-0134771007, 1st Edition, 1990.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, ISBN: 978-0262018029, 1st Edition, 2012.
3. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, ISBN: 978-3319944623, 1st Edition, 2018.
4. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press, ISBN: 978-0262039246, 2nd Edition, 2018.

Other Resources:

1. MIT OpenCourseWare: Artificial Intelligence / Machine Learning / Deep Learning.
   Web Link – https://ocw.mit.edu/
2. fast.ai Course: Practical Deep Learning for Coders.
   Web Link – https://course.fast.ai/
3. Google AI: Machine Learning Crash Course (MLCC).

Web Link – https://developers.google.com/machine-learning/crash-course

4. Kaggle Learn: Machine Learning, Deep Learning, Data Processing Microcourses.
   Web Link – https://www.kaggle.com/learn

A. IN-SEMESTER ASSESSMENT (25 MARKS)

Suggested breakup of distribution

a) Task/Project Evaluation: 20 Marks

- A group of 2/3 students should be assigned a real life problem statement.
- Students are expected to research and collect required resources to develop an intelligent system for the selected problem.
- **Project Grading Scheme (Total: 20 Marks)**

  Knowledge Representation,Reasoning and Goal Based Planning (Task 1 to Task 3) – 4 Marks

  Identification of entities, attributes, relationships, and constraints;designing rules; and implementation of state-space models.

  - **Feature Engineering ,ML Model Training and Evaluation (Task 4 & Task 5) – 6 Marks**

    Handling missing values, ensuring consistency; feature selection techniques;Training ML models, and evaluating performance.
  - **Deep Learning and Interpretability (Task 7 & Task 8) – 6 Marks**

    Design, training and evaluating deep learning models and interpretability tools.
  - **System Integration and Deployment (Task 9 & Task 10) – 4 Marks**

    Integration, deployment and testing of an intelligent system.

b) Regularity & Active participation: 05 Marks

B. END SEMESTER EXAMINATION (Practical and Oral Exam) (25 MARKS)

Suggested breakup of distribution

a) Task Execution: 10 Marks

Students will be given task (different task for every student) and will be evaluated as per the parameters mentioned in continuous assessment.

b) Results and discussion, Inferences drawn from the above task: 05 Marks

c) Oral based on entire syllabus: 10 Marks

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

Course Type	Course Code	Course Name	Credits
CELBC711	CELBC711	ADVANCE SECURITY LABORATORY	01

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

Pre-requisite:

CESBL301 Python Programming

Program Outcomes addressed:

1. PO2: Problem Analysis
2. PO3: Design/Development of Solutions
3. PO4: Conduct investigations of complex problems
4. PO5: Modern tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO8: Individual and Collaborative Team work
8. PO9: Communication
9. PO11: Life-long learning

Course Objectives:

1. Equip students with practical skills and knowledge to pursue careers in cybersecurity and digital forensics, emphasizing real-world incident response capabilities.
2. To foster proficiency in conducting security assessments including passive and active reconnaissance, vulnerability scanning, and threat analysis.
3. To develop competence in investigating, analyzing, and mitigating web-based security threats—such as session hijacking, CSRF, and authentication flaws.
4. To enable students to design, implement, and apply custom Python-based forensic tools.

Module	Detailed Contents	Hrs.
	Course Introduction This lab introduces students to **Advance Security and Digital Forensics Lab** course. It provides an in-depth look at investigating cybercrimes. The students will learn to collect, preserve, and analyze digital evidences using open source tools and methodologies. The lab focuses on hands-on labs with Python scripting, network forensics, and malware analysis, giving them practical skills for real-world scenarios.	
01.	**Overview of Advance Security:** ***Learning Objective:*** *To provide practical knowledge of end-to-end data collection—from proactive security scanning and reconnaissance to post-incident forensic acquisition—enabling the analysis of vulnerabilities, malicious activity, and digital evidence for comprehensive incident response.*	**6**

	Contents: • Overview of advance Security • Perform active and passive reconnaissance • Vulnerability scanning using Open source tools like Nessus, Nikto etc. • Prepare report for the above reconnaissance and vulnerability scanning. **Task 1:** Plan and conduct a complete passive reconnaissance assessment against a target organization and produce an intelligence report without making any direct contact with target systems. ***Learning Outcome:*** *A learner will be able to* *LO 1.1: Plan and conduct an authorized security assessment of a target system using modern scanning tools, while following ethical standards and recognizing the engineer's responsibility to protect public safety. (P.I. – 2.1.2, 5.1.1, 6.1.1, 7.1.1, 8.1.1).* **Task 2:** Perform authorized active reconnaissance and vulnerability scanning against target systems and produce a detailed technical security report. ***Learning Outcome:*** *A learner will be able to* *LO 1.2: Perform an authorized security assessment by proficiently using tools like Nessus, Nikto etc. to analyze vulnerabilities, synthesize the findings into a cohesive team report, and responsibly contextualize the technical risks within their societal and ethical implications. (P.I. – 2.4.2, 5.2.2, 6.3.1, 7.2.2, 8.3.1).*	
02.	**Web Application Security:** ***Learning Objective:*** *To investigate, exploit, analyze, and defend against modern web-based attacks by applying security principles to vulnerabilities in authentication, session management, and client-side security.* **Contents:** • Cyber Crime Investigation and forensics methodologies • OWASP, Web Security Considerations • User Authentication and Session Management, Cookies • Web Browser Attacks • Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management **Task 3:** Execute a simulated attack chain (e.g., session hijacking → CSRF → Clickjacking) against a test web application and then conduct a forensic investigation by analyzing logs and artifacts to reconstruct the attack and produce an evidence report. ***Learning Outcome:*** *A learner will be able to* *LO 2.1: Plan and execute a simulated web attack chain, apply analytical and mathematical techniques to reconstruct the incident through forensic investigation, systematically evaluate security flaws, proficiently use relevant tools, assess the wider risks and impacts of the vulnerabilities, navigate ethical considerations responsibly, and collaborate effectively within a team to produce a detailed forensic report. (P.I. – 2.1.2, 2,4,1, 3.3.1, 5.2.2, 6.3.1, 7.1.1, 8.1.1).*	**8**

	Task 4: Perform a security audit of provided web application code or architecture to identify authentication, session management, and OWASP-related vulnerabilities, then design and document specific mitigations and a forensic readiness plan. ***Learning Outcome:*** *A learner will be able to* *LO 2.2: Perform a security audit of a web application, identify vulnerabilities using modern tools, propose and integrate effective mitigations, contextualize the findings within professional ethics and public safety responsibilities, and communicate the results clearly as part of a collaborative team. (P.I. – 2.4.2, 3.4.2, 5.1.1, 6.1.1, 7.2.2, 8.2.1)*	
03.	**Introduction to Digital Forensics:** ***Learning Objective:*** *To apply forensic methodologies and Python scripting for the collection and analysis of digital evidence from diverse sources while maintaining legal chain of custody.* **Contents:** • Cyber Crime Investigation and forensics methodologies. • Cyber Incident handling and response. • Controlling contamination- chain of custody • Setting up an electronic evidence forensics laboratory, and File identification and profiling in Windows and Linux • Applying Forensics to Computer Networks using tools like tshark, wireshark, tcpdump & xplico. • Email forensics **Task 5:** Setting up an electronic evidence forensics laboratory and Collecting data from system memory (system registers, cache, RAM) in raw form and then carving the data from Raw dump. using the tools like Autopsy, Sleuth-kit etc. ***Learning Outcome:*** *A learner will be able to* *LO 3.1: Perform the setup of an electronic forensics laboratory, formulate a plan for collecting raw system memory data, and apply modern forensic tools to perform data carving from the acquired memory dump in a team. (P.I. – 2.1.2, 4.3.1, 5.1.1, 8.3.1)* **Task 6:** Collection of network traffic data, analysing the traffic and preserving original. ***Learning Outcome:*** *A learner will be able to* *LO 3.2: Collect and analyze network traffic using systematic evaluation methods while establishing and adhering to clear team roles and procedures for evidence preservation and preparing report. (P.I. – 3.3.1, 5.2.2, 8.1.1,9.3.2)* **Task 7:** Investigate Email Headers, identify sender's IP address, verify emails and fake email investigations. ***Learning Outcome:*** *A learner will be able to* *LO 3.3: Investigate email headers using a structured methodology, analyze the data to verify sender authenticity, integrate the findings into a clear report and presentation, and identify any learning gaps for future skill development. (P.I. – 2.4.2, 3.4.2, 4.2.1, 9.2.2, 11.1.1)*	**10**

04.	**Development of forensics tools using python libraries** ***Learning Objective:*** *To develop proficiency in implementing custom digital forensics tools using Python libraries, enabling the collection, analysis, and reporting of evidence from various digital sources.*	**6**
	Contents: • Develop tools using python libraries for digital forensics. **Task 8**: Develop individual Python scripts to perform a variety of forensic collection and analysis tasks, including working with encrypted files, extracting metadata, examining Windows artifacts, tracking web and email usage, footprinting applications, carving artifacts from volatile memory, carving file systems, and analyzing network traffic using appropriate digital forensics libraries. ***Learning Outcome:*** *A learner will be able to* *LO 4.1: Design and implement multiple Python scripts for digital forensics by identifying and formulating specific forensic problems, systematically evaluating alternative approaches to evidence collection, using appropriate procedures and forensic libraries to collect and analyze data from diverse sources with proficiency in discipline-specific tools, within a team. (P.I. – 2.1.2, 3.3.1, 4.3.1, 5.2.2, 8.1.1, 9.3.2, 11.3.1)* **Task 9**: Analyse a complex forensic case using a combination of the scripts developed in **Task 8**, synthesize the collected evidence from multiple sources, and collaborate within a team to produce a comprehensive technical report that clearly presents findings using various media formats. ***Learning Outcome:*** *A learner will be able to* *LO 4.2: Examine a complex digital investigation using their own forensic scripts, combine evidence from different places, create a clear and detailed report using text, images, and other formats, and back up their findings with reliable technical sources. (P.I. – 2.4.2, 3.4.2, 4.3.4, 5.1.1, 8.3.1, 9.1.2, 11.3.1)*	
	Total Hours	**30**

Performance Indicators:

P.I. No.	P.I. Statement
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem
2.4.1	Apply engineering mathematics / principles to solve a problem
2.4.2	Analyse and interpret the results using contemporary tools.
3.3.1	Able to perform systematic evaluation of the degree to which several design concepts meet the criteria.
3.4.2	Able to implement and integrate the modules.
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
5.1.1	Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities
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
6.3.1 Identify risks/impacts in the life-cycle of an engineering product or activity
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
9.2.2 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
11.1.1 Describe the rationale for the requirement for continuing professional development
11.3.1 Source and comprehend technical literature and other credible sources of information

Course Outcomes (COs):

Learner will be able to:

1. Execute, and analyse both passive and active security reconnaissance assessments against authorized targets by applying appropriate tools and methodologies, while responsibly synthesizing findings into professional reports that adhere to ethical standards and consider societal impact. (Mapped LOs: 1.1, 1.2)
2. Investigate, exploit, analyse, and defend against modern web-based attacks by applying security principles and ethical practices to vulnerabilities in authentication, session management, and client-side security. (Mapped LOs: 2.1, 2.2)
3. Implement forensic methodologies to collect, analyze, and report on digital evidence from diverse sources such as file systems, networks, and email, while maintaining legal chain of custody and adhering to ethical standards. (Mapped LOs: 3.1, 3.2, 3.3)
4. Design, implement, and apply custom Python-based forensic tools to collect and analyse digital evidence from diverse sources, systematically evaluate forensic problems, and collaboratively synthesize findings into comprehensive technical reports using appropriate methodologies and ethical practices. (Mapped LOs: 4.1, 4.2)

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CELBC711.1	--	3	--	--	3	3	3	3	--	--	--
CELBC711.2	--	3	3	--	3	3	3	3	--	--	--
CELBC711.3	--	3	3	3	3	--	--	3	3	--	2
CELBC711.4	--	3	3	3	3	--	--	3	3	--	3
Average	--	3	3	3	3	3	3	3	3	--	3

Text Books :

1. Dafydd Stuttard, “The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws”,Wiley, ISBN: 978-1118175231, 2nd edition, Aug 2011.
2. Marjie T. Britz, “Computer Forensics and Cyber Crime: An Introduction”, Pearson Publication, ISBN: 978-0132677714, 3rd edition, May 2013.
3. Ec-council, Computer Forensics Evidence Collection and Preservation, Cengage Learning, 2010.
4. Chapin Bryce,” Python Digital Forensics Cookbook: Effective Python recipes for digital investigations”, Packt Publishing, 2017.

Reference Books:

5. Eoghan Casey, “Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet”, Academic Pr, Apr 2011
6. Jon EricksonJon Erickson, “Hacking: The Art of Exploitation”, No Starch Press, 2008.
7. Gerard Johansen., “Digital Forensics and Incident Response”, Packt Publishing Limited, 2020.

Other Resources:

1. NPTEL Course: Practical Cyber Security for Cyber Security Practitioners by Prof. Sandeep K. Shukla, IIT Kanpur Web Link- https://nptel.ac.in/courses/106104467
2. Swayam Tutorial: Internet Crimes and Cyber Security By Prof. K.V.K Santhy, Prof. B Md Irfan, NALSAR University of Law Web Link: https://onlinecourses.nptel.ac.in/noc26_lw01/preview

A. IN-SEMESTER ASSESSMENT (25 MARKS)
Suggested breakup of distribution

a) Task/Project Evaluation Instructions: 20 Marks

- A group of 2 students should be formed
- Each group is expected to perform active and passive reconnaissance on safe to hack sites and prepare report. 10 Marks.
- Each group should perform any one tasks among task (3-4) and showcase the results and inferences – 10 marks

b) Regularity & Active participation: - 05 Marks

B. END SEMESTER EXAMINATION (Practical and Oral Exam) (25 MARKS)
Suggested breakup of distribution

a) Task Execution: - 10 Marks
Students will be given a task (different task for every student) from task (1-4) and will be evaluated as per the parameters.

b) Oral Exam: - 15 Marks

An oral examination based on the implementation, results, and inferences drawn from Tasks 5–9 for each group will be conducted and evaluated by both internal and external examiners.

Course Type	Course Code	Course Name	Credits
MJP	MJP701	MAJOR PROJECT-A	02

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 & The World
7. PO7 : Ethics
8. PO8 : Individual and Collaborative Teamwork
9. PO9 : Communication
10. PO10: Project Management & Finance
11. PO11: Life-Long learning

Course Objectives

1. To motivate students to review the knowledge and skills they acquired during their program.
2. To ensure students can analyze a specific problem or issue, and they can demonstrate proficiency in project design, research methods application, data collection and analysis, and results presentation.
3. To foster self-learning and research skills.

Course Outcomes

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

1. Identify and define a problem of societal or research relevance through a comprehensive literature review and a detailed problem analysis.
2. Apply appropriate engineering principles, analytical methods, and modern tools to design feasible and effective solutions for the identified problem.
3. Conduct investigations using suitable research methodologies, data collection, and analysis techniques to validate the proposed solution.
4. Evaluate the proposed solution considering societal, environmental, and ethical aspects to ensure sustainable engineering practices.
5. Demonstrate effective teamwork, project management, and communication skills in preparing and presenting project outcomes.
6. Engage in self-directed learning and continuous improvement to enhance technical competence and professional growth.

A. Guidelines for the Major Project-A

Guidelines

1. Project Topic Selection and Allocation

- Towards the end of Semester VI, students will be introduced to potential project domains and problem areas.
- Project topics must be finalized in consultation with the guide, ensuring technical feasibility and alignment with the guide's domain expertise.

- Students should refer to recent research papers (preferably from IEEE, Elsevier, ACM, or similar sources) not older than three years.
- Students are encouraged to propose original ideas, including problem statements inspired by Digital India initiatives, Smart India Hackathon (SIH), and other innovation platforms.

Criteria for Topic Finalization:

- Novelty: The work should introduce new contributions or address clear gaps in existing systems.
- Technological Relevance: Use of current and emerging tools, platforms, methods, and technologies.
- Originality: Avoid repetition of projects undertaken in the past three years.
- Product Orientation (Preferred): Solutions that can evolve into a deployable product or prototype.

Project Team & Execution:

- Each group must consist of 3–4 students (within the same or across departments).
- Projects may be executed internally or in collaboration with industry, research organizations, or external agencies.
- Guides will be allotted to monitor progress, review weekly work, and maintain attendance and log records.
- Topic proposals will be reviewed domain-wise, and final approval will be given by the HoD and the project coordination committee.

2. Project Progress Monitoring

- Each department shall constitute a Project Progress Monitoring Committee.
- Minimum two formal progress presentations must be conducted during the semester.
- Internal guides may coordinate with industry/external partners for off-campus project supervision if required.

3. Project Report Format

The final report should follow the institute guidelines and include:

1. Abstract
2. Introduction
3. Literature Review / Existing System
4. Research Gap / Limitations
5. Problem Statement and Objectives
6. Proposed System
    - Analysis / Algorithm / Framework
    - Design Methodology
7. Experimental Setup
    - Input Data / Dataset Details
    - Software and Hardware Specifications
    - Evaluation Parameters
8. Results and Discussion
9. Conclusion and Future Scope
10. References
11. Appendices (if applicable: Certificates, Publications, etc.)

Students are encouraged to complete relevant certification courses that support the technical requirements of their project.

B. In-Semester Continuous Assessment (Evaluation)

Total Marks: 50 (Semester VII)

Component	Description	Marks
Topic Approval Presentation	**Evaluation by Project Monitoring Committee**	**10**
Mid-Semester Progress Presentation	**Demonstration of progress in methodology and implementation**	**15**
Final Report & Presentation	**Quality of report, implementation, teamwork, and final demonstration**	**20**
Regularity and active participation	**Consistent attendance, timely submission of weekly progress logs, proactive involvement in group discussions, task ownership, and meaningful contribution to project development throughout the semester.**	**05**

Quality Evaluation Parameters

- Relevance and quality of the problem selected
- Clarity in problem definition, objectives, and scope
- Originality and relevance to current industry/research trends
- Quality of system design, methodology, and implementation
- Clarity, organization, and technical depth of the report
- Effectiveness of oral presentation
- Individual contribution and teamwork

Course Type	Course Code	Course Name	Credits
HSS	HSS703	FINANCIAL PLANNING	02

Program Outcomes addressed:

1. PO2 : Problem Analysis
2. PO6 : The Engineer & The World
3. PO10: Project Management and Finance

Course Objectives :

1. Develop a foundational understanding of financial principles and their relevance to personal financial planning
2. Enhance analytical skills to assess financial situations and propose effective solutions.
3. Acquire practical financial management skills through budgeting, investment analysis, and debt management
4. Foster ethical and responsible financial behaviour in alignment with professional standards and societal values

Module	Details
01.	**Setting Financial goals, Budgeting & cash flow management** Understanding financial goals: short, medium, long-term, and setting them using the SMART criteria, Introduction to budgeting: covering income, expenses, savings, and investments, Budgeting techniques: zero-based budgeting, envelope system, and the 50/30/20 rule, Cash flow management strategies for maintaining financial stability.
02.	**Saving Strategies & Investments, Borrowing & Credits** Importance of saving and investing for financial growth, Introduction to different types of savings accounts and investment options, Understanding the risk-return tradeoff in investing, Diversification and asset allocation strategies, Responsible borrowing practices and managing debt, Credit management: credit scores, types of credit, and building good credit history.
03.	**Risk Management** Concept of financial risk and its implications, Types of financial risks: market risk, inflation risk, interest rate risk, credit risk, Introduction to insurance: types of insurance (life, health, property, auto), coverage options, Importance of emergency fund and risk mitigation strategies Evaluating risk tolerance and creating a risk management plan
04.	**Income tax Fundamentals** Basics of income tax: taxable income, tax deductions, tax credits, understanding tax brackets and marginal tax rates, Types of taxes: income tax, payroll tax, capital

	gains tax, Filing tax returns: forms, deadlines, filing options, Tax-saving strategies: deductions, credits, retirement accounts
05.	**Understanding balance sheet** Introduction to personal financial statements, Components of a balance sheet: assets, liabilities, net worth, Understanding the relationship between income statement and balance sheet, Importance of tracking and analyzing personal financial position, Evaluating financial health using key ratios (debt-to-income ratio, savings ratio, etc.)
06.	**Project management & Finance** Introduction to project management principles, Project planning and scheduling: defining objectives, work breakdown structure, Gantt charts Budgeting for projects: estimating costs, resource allocation, contingency planning, Project risk management: identifying risks, assessing impact, developing risk response strategies, Financial analysis techniques for project evaluation (NPV, IRR, payback period)
Total no. of hours: **30**	

Course Outcomes :

1. Demonstrate a comprehensive understanding of financial concepts
2. Analyze complex financial scenarios, identify financial challenges, and propose effective strategies to achieve financial goals.
3. Apply financial planning principles and techniques to develop personalized financial plans aligned with individual goals and circumstances.
4. Utilize financial tools, software applications, and online resources proficiently
5. Adhere to ethical standards and professional codes of conduct in financial decision-making
6. Recognize the societal impact of financial decisions and promote responsible financial behavior

Text Books :

1. Personal Finance by Jeff Madura and Hardeep Rai, Pearson Education
2. Financial Management: Principles and Applications, by Sheridan Titman, Arthur J. Keown, and John D. Martin, Pearson Education
3. Project Management: The Managerial Process, by Erik W. Larson and Clifford F. Gray, McGraw-Hill Education

Reference Books :

1. The Total Money Makeover: A Proven Plan for Financial Fitness, by Dave Ramsey, Thomas Nelson
2. Investing 101: From Stocks and Bonds to ETFs and IPOs, an Essential Primer on Building a Profitable Portfolio, by Michele Cagan , Adams Media
3. Financial Risk Management: A Practitioner's Guide to Managing Market and Credit Risk, by Steve L. Allen (Publisher: Wiley)

Other Resources:

1. NPTEL Course: Behavioral And Personal Finance, By Prof. Abhijeet Chandra, Vinod Gupta School of Management, IIT Kharagpur :-Web link- https://onlinecourses.nptel.ac.in/noc24_mg07/preview

2. NPTEL Course: Financial Management, By CA Amita Bissa, Jai Narain Vyas University, Jodhpur:-Web link- https://onlinecourses.swayam2.ac.in/cec20_mg05/preview

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.

(**Note:** The proposed course will be offered subject to the availability of course during FH- 2027)

Program Elective-V	
CEPEC8051	Social Network Data Analytics: 12-week course **Proposed Course:** Social Network Analysis By Prof. Tanmoy Chakraborty | IIIT Delhi https://onlinecourses.nptel.ac.in/noc22_cs117/preview
CEPEC8052	Software Development: 12-week course **Proposed Course:** Software Engineering By Prof. Rajib Mall | IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_cs68/preview
CEPEC8053	Network and Security: 12-week course **Proposed Course:** Network Security By Prof. Gaurav S. Kasbekar | IIT Bombay https://onlinecourses.nptel.ac.in/noc26_ee20/preview
CEPEC8054	Machine Intelligence: 12-week course **Proposed Course:** Machine Learning for Engineering and science applications **By Prof. Balaji Srinivasan, Prof. Ganapathy Krishnamurthi | IIT Madras** https://onlinecourses.nptel.ac.in/noc26_cs76/preview

Course Type	Course Code	Course Name	Credits
OEC	OEC8021	PROJECT MANAGEMENT	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. PO5: Engineering Tool Usage
5. PO9: Communication
6. PO10: Project Management and Finance
7. PO11: Life-long learning

Course Objectives:

1. To familiarize students with fundamental project management concepts, frameworks, tools, and standard terminology relevant to engineering projects.
2. To enable students to analyze project requirements and apply systematic project selection techniques and portfolio management approaches for informed decision-making.
3. To enable students to plan projects effectively by developing work breakdown structures, schedules, budgets, and comprehensive risk management plans.
4. To equip students to monitor and control project progress using quantitative performance measurement techniques, including Earned Value Management.
5. To evolve students' leadership, communication, ethical awareness, and technical documentation skills necessary for effective project execution and formal project closure.

Module	Detailed Contents	Hrs.
00.	**Course Introduction** In today's technology-driven and highly competitive engineering environment, effective project management has become critical for delivering complex projects within defined time, cost, quality, and resource constraints. Rapid technological advancements, multidisciplinary teams, and increased stakeholder expectations demand a structured approach to planning, execution, monitoring, and control of projects. This course provides students with a comprehensive understanding of project management principles, practices, and tools essential for managing engineering projects successfully. It covers key areas such as project selection and feasibility analysis, scope definition, scheduling techniques, cost and quality management, risk assessment, and performance monitoring using methods such as Earned Value Management. The course also addresses leadership, communication, and ethical considerations, enabling students to manage projects systematically in professional and industry-oriented environments.	01
01.	**Fundamentals of Project Management**	04-06
	Contents: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI).	
02.	**Project Selection, Initiation, and Feasibility Analysis**	06-08
	Contents: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio	
03.	**Project Planning and Scheduling Techniques**	07-09
	Contents: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	
04.	**Planning Project and Risk Management**	06-08
	Contents: Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan, Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks.	
05.	**Project Monitoring, Control, and Contracting**	06-08

	Contents: Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit. Project Contracting, Project procurement management, contracting and outsourcing.	
06.	**Project Leadership, Closure and Documentation**	**04-06**
	Contents: Introduction to project leadership, ethics in projects, Multicultural and virtual projects. Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lesson learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
	Course Conclusion: Upon completion of the Project Management course, students will be able to systematically plan, manage, monitor, and close engineering projects using established project management principles and tools. They will demonstrate the ability to work effectively in teams, manage risks and stakeholders, make informed managerial decisions, and document lessons learned. The course prepares students to take on professional roles that require project coordination, leadership, and ethical responsibility in real-world engineering and organizational environments.	**01**
	Total	**45**

Course Outcomes: A learner will be able to-

1. Apply engineering fundamentals to interpret project management concepts, project life cycle phases, stakeholder roles, and organizational structures required for systematic project execution.
2. Analyze and evaluate project proposals using structured selection and feasibility techniques, identify tasks and resources for project initiation, assess economic viability, and apply engineering principles to understand team development and dynamics.
3. Design and develop comprehensive project plans using work breakdown structures, cost estimation, and scheduling techniques, apply modern project management tools to optimize time and resource utilization, and evaluate project plans based on economic and financial considerations.
4. Apply project planning, communication, and risk management techniques to allocate and optimize resources, manage schedule uncertainties, engage stakeholders effectively, and analyze project risks to select appropriate response strategies for successful project execution.

5. Analyze, Monitor and control project performance using planning and execution parameters, applying quantitative measurement and modern project management tools, managing stakeholder communication and team coordination, and identifying procurement and contracting activities to ensure effective project execution.
6. Apply, demonstrate, and document project leadership and communication skills to execute project closure activities, manage project termination processes, ensure customer acceptance, and prepare formal closure reports and lessons learned for professional growth and knowledge management.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8021.1	3	-	-	-	-	-	-	-	-	-	-
OEC8021.2	3	3	-	-	-	-	-	-	-	3	-
OEC8021.3	-	-	3	-	3	-	-	-	-	3	-
OEC8021.4	-	3	-	-	-	-	-	-	3	3	-
OEC8021.5	-	3	-	-	3	-	-	-	-	3	-
OEC8021.6	3	-	-	-	-	-	-	-	3	-	3
Average	**3**	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**3**	**3**

Text Books:

1. Project Management: A Managerial Approach, Meredith, J. R. and Mantel, S. J. Jr., 2017, Wiley India, ISBN: 978-1-119-36911-7, 9th Edition.
2. Project Management: Planning, Scheduling, and Controlling, Chitkara, K. K., 2014, Tata McGraw-Hill Education, ISBN: 978-0-070-67713-9, 2nd Edition.
3. Project Management: The Managerial Process, Gray, C. F. and Larson, E. W., 2018, McGraw-Hill Education, ISBN: 978-1-259-66271-6, 7th Edition.
4. Project Management, Gopalan, M. R., 2014, Wiley India Pvt. Ltd., ISBN: 978-8126550807, 2nd Indian Edition.

Reference Books:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute, 2017, PMI Publications, ISBN: 978-1-62825-664-2, 6th Edition.
2. Successful Project Management, Gido, J. and Clements, J. P., 2018, Cengage Learning, ISBN: 978-1-337-10067-2, 6th Edition.
3. Project Management, Lock, D., 2014, Gower Publishing, ISBN: 978-1-409-46228-6, 10th Edition.

Other Resources:

1. NPTEL Course: Project Management by Prof. K. K. Aggarwal / Prof. S. C. Dutta, IIT Delhi
   Web Link – https://onlinecourses.nptel.ac.in
2. Project Management Institute (PMI), PMBOK® and Standards Repository, Online Resource
   Web Link – https://www.pmi.org

3. MIT OpenCourseWare, Project Management and Systems Engineering, Massachusetts Institute of Technology. Web Link – https://ocw.mit.edu
4. Coursera, Project Management Principles and Practices, University of California, Irvine Web Link – https://www.coursera.org

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

1. Assignment on live problems/case studies: 10 Marks

   (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.)

2. Technical Report Writing: 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
OEC	OEC8022	FINANCE MANAGEMENT	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. PO10: Project Management & Finance

Course Objectives :

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Overview of Indian Financial System**	**05-07**
	Contents: Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	
02.	**Concepts of Returns and Risks**	**6-8**
	Contents: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	

	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuit y Due; Continuous Compounding and Continuous Discounting	
03.	**Overview of Corporate Finance** **Contents:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	**09-11**
04.	**Capital Budgeting** **Contents:** Meaning and Importance of Capital Budgeting; Inputs forCapital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's10 Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	**10-12**
05.	**Sources of Finance** **Contents:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	**05-07**
06.	**Dividend Policy** **Contents:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani- Miller Approach	**02-04**
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8022.1	3	3	-	-	-	-	-	-	-	-	-
OEC8022.2	3	3	-	-	-	-	-	-	-	3	-
Average	**3**	**3**	**-**	**-**	-	-	-	-	-	**3**	**-**

References :

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC8023	ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT	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: NIL

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO6: The Engineer & The world
3. PO8: Individual and team work
4. PO9: Communication
5. PO10: Project Management & Finance
6. PO11: Lifelong Learning

Course Objectives:

1. To introduce the fundamental concepts of entrepreneurship and effective management of business enterprises.
2. To develop understanding of business planning, ownership structures, and legal aspects related to entrepreneurship.
3. To familiarize students with the Indian entrepreneurial environment, including MSMEs, government policies, and support institutions.
4. To encourage entrepreneurial thinking by highlighting innovation, sustainability, and problem-solving in small and medium enterprises.

Module	Detailed Contents	Hrs
00.	**Course Introduction** This course is designed to develop a clear understanding of entrepreneurship as a career option and as a driver of economic growth. It covers the fundamentals of starting, organizing, and managing new ventures with special reference to the Indian business environment. The course explains business planning, legal frameworks, financial management, and government support for entrepreneurs. Emphasis is given to MSMEs, innovation, and sustainable development. Through practical insights and case discussions, the course prepares learners to identify opportunities and manage entrepreneurial challenges effectively.	01
	Overview of Entrepreneurship	

01.	**Content:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	**05-07**
02.	**Business Plans and Importance of Capital to Entrepreneurship**.	**06-08**
	Contents: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur. Entrepreneurship and Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	
03.	**Women and Social Entrepreneurship**	**08-10**
	Contents: Concept and evolution of women entrepreneurship in India. Role and importance of women entrepreneurs in economic and social development. Characteristics, strengths, and challenges faced by women entrepreneurs. Government policies, schemes, and institutional support for women entrepreneurship. Role of self-help groups (SHGs), NGOs, and microfinance institutions in promoting women-led enterprises. Case studies of successful women entrepreneurs. Concept, meaning, and scope of social entrepreneurship. Difference between social entrepreneurship and traditional entrepreneurship. Role of social entrepreneurs in addressing social, economic, and environmental issues. Models of social enterprises and sources of funding.	
04.	**Indian Environment for Entrepreneurship**	**07-09**
	Contents: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organizations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	
05.	**Effective Management of Business**	**04-06**

	Contents: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
06.	**Achieving Success In The Small Business**.	**04-06**
	Contents: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learner will be able to

1. Understand entrepreneurship fundamentals and collaboratively present a basic business plan using effective teamwork, analysis, and communication skills.
2. Interpret business planning, financing, legal, and operational aspects of entrepreneurship, demonstrating the ability to develop, evaluate, and present comprehensive business strategies.
3. Understand the principles of women and social entrepreneurship and associated support systems.
4. Comprehend MSME regulations, financial schemes, and government support systems, and present structured reports for informed decision-making.
5. Identify challenges faced by micro and small enterprises and develop practical solutions, collaboratively presenting integrated case studies and informed management decisions.
6. Understand the small business life cycle and growth strategies, and collaboratively present solutions to real world business challenges.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8023.1	2	--	--	--	--	--	--	3	3	--	--
OEC8023.2	2	--	--	--	--	--	--	--	3	3	--
OEC8023.3	2	--	--	--	--	3	--	3	--	--	3
OEC8023.4	2	--	--	--	--	3	--	--	3	--	--
OEC8023.5	2	--	--	--	--	--	--	3	3	--	--
OEC8023.6	2	--	--	--	--	--	--	3	3	--	--
Average	**2**	--	--	--	--	**3**	--	**3**	**3**	**3**	**3**

Text Books :

1. Poornima Charantimath, Entrepreneurship Development – Small Business Enterprise, Pearson Education.
2. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education.

3. Vasant Desai, Entrepreneurial Development and Management, Himalaya Publishing House.

Reference Books :

1. T. N. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi.
2. Madhurima Lall & Shikha Sahai, Entrepreneurship, Excel Books.
3. C. N. Prasad, Small and Medium Enterprises in Global Perspective, New Century Publications, New Delhi,

Other Resources :

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8024	HUMAN RESOURCE MANAGEMENT	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. PO7 : Ethics
2. PO8 : Individual and Collaborative Teamwork
3. PO10: Project Management and Finance

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Introduction to HR** **Contents:** - Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions - Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	**04-06**
02.	**Organizational Behaviour (OB)**	**07-09**

	Contents: - Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues - Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness - Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior - Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); - Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. - Case study	
03.	**Organizational Structure &Design** **Contents:** - Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. - Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. - Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	**06-08**
04.	**Human resource Planning** **Contents:** - Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale - Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning - Training & Development: Identification of Training Needs, Training Methods	**05-07**
05.	**Emerging Trends in HR** **Contents:** - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	**6-8**

06.	**HR -MIS, Strategic HRM and Labor Laws & Industrial Relations**	**09-11**
	Contents: - Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries - Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals - Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

1. Understand the concepts, aspects, techniques and practices of the human resource management
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8024.1	--	--	--	--	--	--	3	3	--	3	--
OEC8024.2	--	--	--	--	--	--	3	3	--	3	--
OEC8024.3	--	--	--	--	--	--	3	3	--	3	--
OEC8024.4	--	--	--	--	--	--	3	3	--	--	--
Average	--	--	--	--	--	--	**3**	**3**	--	**3**	--

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – (20 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
OEC	OEC8025	PROFESSIONAL ETHICS & CSR	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

Program Outcomes addressed:

1. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Professional Ethics and Business**	**03-05**
	Contents: The Nature of Business Ethics; Ethical, Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
02.	**Professional Ethics in the Marketplace, Professional Ethics and the Environment**	**08-10**
	Contents: - Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy - Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
03.	**Professional Ethics of Consumer Protection, Professional Ethics of Job Discrimination**	**06-08**
	Contents: - Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy - Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
	Introduction to Corporate Social Responsibility	**05-07**

04.	**Contents:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	
05.	**Corporate Social Responsibility**	**08-10**
	Contents: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06.	**Corporate Social Responsibility in Globalizing India**	**07-09**
	Contents: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes : Learner will be able to

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8025.1	--	--	--	--	--	3	3	--	--	3	--
OEC8025.2	--	--	--	--	--	3	3	--	--	3	--
OEC8025.3	--	--	--	--	--	3	3	--	--	--	--
OEC8025.4	--	--	--	--	--	3	3	--	--	3	--
Average	--	--	--	--	--	**3**	**3**	--	--	**3**	--

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC8026	CIRCULAR ECONOMY	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: 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: Lifelong Learning

Course Objectives:

1. To introduce the fundamentals and need for Circular Economy (CE)
2. To impart the knowledge about environmental and economic impacts of products.
3. To make learner understand circular materials and product strategies.
4. To impart the knowledge of CE business models in engineering industries.

Module	Detailed Contents	Hrs
00.	**Course Introduction** This course introduces the Circular Economy (CE) paradigm—a transformative approach that shifts from linear consumption to restorative and regenerative systems. By embracing CE principles, engineers can contribute to designing products, processes, and infrastructures that maximize resource efficiency, reduce waste, and promote economic, environmental, and social sustainability.	01
01.	**Introduction to Circular Economy** **Content:** Linear economy, Role of the Industrial revolution in Linear economy, Disadvantages of Linear economy, Replacing Linear by Circular economy, History and evolution of circular economy, Global CE initiatives (EU Circular Economy Action Plan, UN SDGs), Role of R's in circular economy, Value	05-07

	optimization, Design out waste, Renewable energy, A differential- Linear vs. Circular economy, Building a resilient economy, Role of engineers in CE	
02.	**Systems Thinking and Life Cycle Thinking**	**06-08**
	Contents: Systems Thinking in CE, Core principles of Systems Thinking in CE, Application in the Circular Economy Concept of Loops, Circularity, Life Cycle Analysis(LCA), Importance of LCA, An efficient approach by Neptune Pumps, Case study-winnow solutions, Embodied energy and material flows, Input-output analysis in industrial systems	
03.	**Circular Design and Materials Engineering**	**07-09**
	Contents: Material recovery, waste reduction, Reducing negative externalities, Connecting Businesses and people for circularity, Butterfly diagram, Design for disassembly, modularity, repairability, Materials selection for durability and recyclability , Bio-based and regenerative materials, Eco-design principle	
04.	**Circular Business Models and Industrial Applications**	**07-09**
	Contents: Circular Business Models, Product-as-a-Service (PaaS), Reverse logistics, remanufacturing, and refurbishment, Industrial symbiosis and closed-loop systems, Digital technologies enabling CE (IoT, blockchain, AI)	
05.	**Waste Management and Resource Recovery**	
	Contents: Circular waste hierarchy, Urban mining and e-waste recycling, Industrial and agricultural waste valorization, Waste-to-energy and bioconversion technologies	**06-08**
06.	**Circular Economy Implementation and Policy**	**06-08**
	Contents: CE indicators and metrics (e.g., Circularity Gap Report), National and international CE policies, Corporate sustainability and ESG frameworks, Roadmaps and barriers to implementation	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learner will be able to

1. Analyze the need for Circular Economy (CE) and apply systems and life cycle thinking to engineering
2. Integrate CE in design and material selection
3. Analyse real-world industrial circular practices
4. Apply engineering approaches to waste minimization and resource recovery
5. Analyse policy, regulations, and corporate strategies and integrate CE into engineering practice

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8026.1	3	3	--	--	--	3	3	--	--	3	3
OEC8026.2	3	3	3	--	--	3	--	--	--	3	--
OEC8026.3	3	3	--	--	--	3	3	--	--	--	3
OEC8026.4	3	3	--	--	--	3	3	--	--	--	3
OEC8026.5	3	3	3	--	--	3	3	--	--	--	3
Average	**3**	**3**	**3**	--	--	**3**	**3**	--	--	**3**	**3**

Text Books :

1. Circular Economy: Principles and Benefits, Ken Webster., First Edition 2017, Ellen MacArthur Foundation Publishing.
2. Product Design and Life Cycle Assessment, Ireneusz Zbicinski, Danuta Romanowska, Barbara Bednarowska, First Edition, 2021, Springer
3. Designing for the Circular Economy, Martin Charter, Ursula Tischner, First Edition, 2017 Routledge

Reference Books :

1. The Circular Economy: A User's Guide, Subramanian Senthilkannan Muthu, First Edition, 2020, Springer
2. Industrial Ecology and Circular Economy: Energy and Resource Efficiency in Industry, Yasemin Gursoy, Bilge Sener, First edition, 2021, Springer.
3. Cradle to Cradle: Remaking the Way We Make Things, William McDonough, Michael Braungart, First edition, 2002, North Point Press

Other Resources :

1. NPTEL Course: Sustainable Engineering Concepts and Life Cycle Analysis, Prof. Brajesh Kumar Dubey | IIT Kharagpur
   Web Link- https://onlinecourses.nptel.ac.in/noc24_ce61/preview
2. NPTEL Course: Linear to Circular Economy, Prof Shalini Goyal Bhalla, IIT Roorkee
   Web Link- https://onlinecourses.swayam2.ac.in/aic21_ge19/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
OEC	OEC8027	IPR AND PATENTING	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. PO5: Engineering Tool Usage
4. PO6: The Engineer and The World
5. PO7: Ethics
6. PO8: Individual and Collaborative Team work
7. PO9: Communication
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce students to the significance of Intellectual Property and its impact on innovation and professional growth.
2. To clarify the essential concepts and distinctions among patents, copyrights, trademarks, industrial designs, trade secrets, and GI.
3. To simplify statutory provisions and legal procedures so students can confidently interpret various IPR frameworks.
4. To guide students in applying practical steps for obtaining, managing, and safeguarding different IP rights.
5. To foster ethical reasoning, holistic professional judgement, and awareness of cyber laws relevant to IPR.

Module	Details	Hrs.
00.	**Course Introduction** The course introduces students to the fundamental concepts, legal frameworks, procedures, and applications of Intellectual Property Rights (IPR). With rapid technological advancement, understanding how to protect innovations is essential for engineers. This course equips learners with the knowledge to identify different forms of intellectual property, file and maintain IP rights, and manage IP assets ethically and strategically. Students will also develop awareness of cyber laws as they relate to digital content and IP.	01
01.	**Introduction to IPR** **Contents:** Concept of Property, Tangible and Intangible Property, Intellectual Property: Definition, Need & Importance, Types of IPR: Patents, Copyright, Trademark, GI, Trade Secrets, Industrial Design, Evolution of IP laws: Paris Convention, Berne Convention, WIPO creation, TRIPS, Indian IPR system: CGPDTM, Copyright Office, GI Registry, PVPFR Authority, Role of IPR in R&D, Innovation, and International Trade.	07-09
02.	**Patents** **Contents:** Patent definition, objectives, values and advantages, Criteria of patentability: Novelty, Inventive Step, Industrial Application, Non-patentable inventions under Indian law, Types of Specifications: Provisional, Complete, Parts of a Patent: Title, Field, Background, Description, Drawings, Claims, Abstract, Filing procedure: Forms (1, 2, 3, 5, 9, 18, 26), Examination, FER, Grant, Renewal, PCT Filing, Priority Date, Patent Cooperation Treaty, Revocation, Opposition: Pre-Grant & Post-Grant, Prior art search: Keywords, Boolean operators, Databases (WIPO, USPTO, Google Patents)	08-10
03.	**Trademarks, Industrial Designs and GI** **Contents:** Trademarks: Definition, Functions, Brand Value, Distinctiveness, Types of marks (word, device, shape, color), Registration process, challenges in non-conventional marks, Infringement, Passing off, Domain name disputes, well-known marks. Industrial Designs: Definition, Novelty, Originality, Registration process, Infringement and remedies. Geographical Indications (GI): Meaning & Importance, Registration of GI goods, Indian GI examples.	08-10
04.	**Copyright, Trade Secrets & Emerging IP** **Contents:** Copyright: Meaning, Subject Matter, Economic and Moral Rights, Ownership, Transfer, Licensing, Fair dealing, infringement, remedies, Copyright in the digital era.	07-09

	Trade Secrets: Conditions for protection, Misappropriation, NDAs, employment contracts. Emerging IPR: Plant varieties, Integrated circuit layout designs, Undisclosed information, Digital content issues (streaming, snippet tax)	
05.	**Cyber Laws for Digital IP Protection**	**04-06**
	Contents: Cyber Laws: IT Act 2000**,** Cybercrimes: identity theft, phishing, e-commerce fraud**,** Digital signatures, data protection, privacy**,** International cyber law issues.	
06.	**IP Management, Documentation and Commercialization**.	**03-05**
	Contents: Managing IP: IP documentation, Letters of instruction, Joint collaboration agreements, NDA, Cease & Desist, Settlement memorandum, Assignment & Licensing, Technology Transfer (ToT), IP valuation basics.	
	Course Conclusion	**01**
	The course provides a comprehensive understanding of Intellectual Property Rights and their relevance in engineering, innovation, and global business. Learners gain practical insights into patent drafting, trademark and design registration, copyright compliance, and cyber law frameworks. By the end of the course, students are equipped with knowledge and skills necessary to create, protect, and manage intellectual assets responsibly.	
	Total	**45**

Course Outcomes: Learner will be able to -

1. Compare fundamental IPR concepts by classifying major IP types and outlining key elements of India's IPR policy.
2. Identify key elements of patent fundamentals by outlining patentability criteria, filing steps and prior-art search procedures.
3. Identify essential aspects of trademarks, industrial designs and GI by interpreting legal and registration documentation.
4. Apply copyright, trade-secret and emerging IP provisions by identifying protected subject matter and reviewing case documentation.
5. Analyze cyber laws for digital IP protection by examining cybercrimes, preparing structured reports and evaluating credible cybersecurity and data-privacy information.
6. Evaluate IP management practices by assessing key documentation and critically examining clauses in licensing and collaboration agreements.

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8027.1	--	3	--	--	--	3	3	--	--	--	--
OEC8027.2	--	3	--	--	2	3	3	--	--	--	--
OEC8027.3	--	3	--	--	2	3	--	3	3	3	--
OEC8027.4	3	3	--	--	--	3	--	--	--	--	--
OEC8027.5	3	--	--	--	--	3	--	--	--	--	--
OEC8027.6	--	3	--	--	--	3	--	--	--	--	--
Average	**3**	**3**	**--**	**--**	**2**	**3**	**3**	**3**	**3**	**3**	**--**

Text Books :

1. D. E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents & Trade Secrets, Cengage Learning, 2012.
2. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, 2nd ed., McGraw-Hill Education, 2010.
3. P. Narayanan, Intellectual Property Law, 3rd ed., Eastern Law House, 2010.

Reference Books :

1. F. Ali, The Law of Patents, LexisNexis, 2017.
2. R. Stim, Patent, Copyright & Trademark, 17th ed., NOLO Press, 2019.
3. WIPO, WIPO Intellectual Property Handbook, World Intellectual Property Organization, 2020.
4. K. C. Kailasam and R. Vedaraman, Law of Trademarks and Passing Off, LexisNexis, 2013.

Other Resources :

1. NPTEL Course: Intellectual Property Rights and Competition Law
   Web link- https://onlinecourses.nptel.ac.in/noc25_mg132/preview

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment - Theory (20 Marks)

Suggested breakup of distribution

One class test	:	05 Marks
Article reading and summarization	:	05 Marks
A task based group activity	:	05 Marks
Regularity and attentiveness	:	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
OEC	OEC8028	DISASTER MANAGEMENT AND MITIGATION MEASURES	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: NIL

Program Outcomes addressed:

1. PO1: Engineering Knowledge
2. PO2: Problem Analysis
3. PO3: Design/Development of Solutions
4. PO5: Modern Tool usage
5. PO6: The Engineer and The World
6. PO7: Ethics
7. PO8: Individual and Collaborative Team Work
8. PO10: Project Management and Finance

Course Objectives:

1. To introduce fundamental concepts of disasters and relevance of disaster studies in engineering practice.
2. To convey causes and impacts of natural, human-induced, and emerging disasters
3. To familiarize students with disaster management frameworks and governance by studying national institutions, policies and international disaster risk reduction frameworks
4. To introduce modern technologies, geospatial tools, and data-driven approaches used in disaster management for risk reduction.
5. To teach concepts of disaster response, financing, and recovery mechanisms by analysing relief operations, logistics, medical response, risk financing, and Build Back Better principles.
6. To guide students about mitigation, preparedness, and community resilience by emphasizing structural and non-structural mitigation and ethical responsibility of engineers.

Module	Details	Hours
00.	**Course Introduction** Disaster Management and Mitigation Measures is an interdisciplinary course that equips engineering students with essential knowledge to understand, assess, and reduce the impacts of natural and human-induced disasters. The course introduces fundamental disaster concepts,	**01**

	global and Indian disaster trends, and the growing influence of climate change and extreme events on society and infrastructure. Emphasis is placed on the role of engineers in disaster risk reduction through safe design, planning, technology adoption, and resilient infrastructure development. Students gain insights into disaster preparedness, response, mitigation strategies, and emerging risks, enabling them to contribute effectively to sustainable development, community safety, and national resilience in an increasingly hazard-prone world.	
01.	**Foundations of Disaster Risk Science**	**06-08**
	Contents: Disaster Concepts & Impacts: Direct, indirect and cascading effects, Social, economic & environmental consequences, Disaster-induced development challenges. Risk & Hazard Assessment: Components of disaster risk, Hazard identification & vulnerability assessment, Multi-hazard environment. Climate Change & Emerging Risks: Heatwaves, drought intensification, extreme rainfall, Sea-level rise & coastal vulnerability, Urban heat islands. Indian Context, India's hazard zonation: seismic, cyclone, landslides, flood, drought, Disaster statistics & case studies	
02.	**Natural & Human-Induced Disasters**	**05-07**
	Contents: Natural Disasters: Geological: Earthquakes, Tsunamis, Volcanoes, Landslides, Hydro-meteorological: Flood, Flash Flood, Drought, Cyclones, Cloudburst, Climate-related: Heatwaves, extreme weather events. Human-Induced & Technological Disasters: Industrial accidents, Chemical disasters (Bhopal), Nuclear hazards (Fukushima), Fire hazards (urban & industrial) Transportation accidents (rail/road/air/maritime), Infrastructure failures (dams, bridges, tunnels), Cyber-disasters & critical infrastructure cyber threats.	
03.	**Disaster Management Frameworks, Policy & Governance**	**07-09**
	Contents: Disaster Management Principles: Disaster management cycle, prevention, preparedness, response, recovery. Indian Disaster Governance: NDMA, SDMA, DDMA, NIDM roles and frameworks, National & state policies. International Frameworks & Standards: Sendai Framework for Disaster Risk Reduction, UNDRR, Sphere Standards, Global Humanitarian Principles, ESG & resilience reporting.	
04.	**Technology, Tools & Geospatial Intelligence**	**07-09**

	Contents:	
	GIS, Remote Sensing & GPS Applications: Demand Assigned Access Hazard mapping, Flood/landslide susceptibility mapping, Satellite-based early warning Modern Technologies: Drones & UAVs for reconnaissance, Web GIS platforms AI/ML & Data Analytics: ML models for rainfall, cyclone, flood prediction, Computer vision for damage assessment Smart Disaster Technologies: IoT-based early warning systems, Digital twins for urban planning, Smartphone apps (GEM, IMD, NDMA tools.	
05.	**Financing, Response, Relief & Rehabilitation**	**06-08**
	Contents: Disaster Financing Mechanisms: Risk financing & risk transfer, Insurance models (crop, property, catastrophe bonds), Pradhan Mantri Fasal Bima Yojana & other Indian schemes. Response & Relief Operations: Search & Rescue by NDRF, SDRF, NGOs, armed forces, Logistics management & supply chain resilience, Medical triage & emergency health systems. Recovery, Rehabilitation & Build Back Better: Post-disaster needs assessment (PDNA), Reconstruction policies, Resilient infrastructure design, Community resilience & social inclusion.	
06.	**Preventive, Mitigation & Community-Based Approaches**	**06-08**
	Contents: Structural Mitigation: Seismic design, retrofitting, Cyclone shelters & bio-shields, Flood protection structures, Storm-water management. Non-Structural Mitigation: Policy intervention & awareness, Capacity building, Early warning & communication systems, Land-use planning/zoning. Community Based Disaster Risk Reduction: Role of community institutions, NGOs & volunteers, Risk communication models, Indigenous knowledge systems	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes:

Learners will be able to

1. Summarize disaster concepts and analyse impacts and risk components in multi-hazard environments.

2. Classify and evaluate natural, human-induced, and technological disasters with reference to Indian and global case studies.

3. Interpret disaster management policies, governance frameworks, and institutional roles at national and international levels.

4. Apply modern tools and technologies such as GIS, remote sensing, and data analytics for disaster risk reduction.

5. Formulate/Design mitigation, preparedness, and recovery strategies incorporating community participation, sustainability, and resilience principles.

CO-PO Mapping Table with Correlation Level:

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8028.1	3	3	--	--	--	--	--	--	--	--	--
OEC8028.2	3	--	--	--	--	3	--	--	--	--	--
OEC8028.3	--	3	--	--	--	--	3	--	--	--	--
OEC8028.4	--	--	--	--	3	3	-	--	--	--	--
OEC8028.5	--	--	3	--	--	3	3	--	--	--	--
Average	**3**	**3**	**3**	**--**	**3**	**3**	**3**	**--**	**--**	**--**	**--**

Text Books:

1. D. P. Coppola, *Introduction to International Disaster Management*, 3rd ed. Oxford, U.K.: Butterworth-Heinemann (Elsevier), 2015.
2. R. Shaw, S. Srinivas, and A. Sharma, *Disaster Risk Reduction: Methods, Approaches and Practices*, Singapore: Springer, 2014.
3. P. Sammonds, T. Glade, and M. Bubeck, *Disaster Management and Mitigation: Early Warning Systems, Community Resilience and Sustainability*, London, U.K.: Springer, 2016.
4. D. Alexander, *Natural Disasters*, 2nd ed. Dordrecht, The Netherlands: Springer, 2000.
5. A. S. Arya, *Disaster Management: Institutions and Policies*, New Delhi, India: Gyan Publishing House, 2006.

Reference Books:

1. A. K. Jha, R. Duyne Barenstein, P. M. Phelps, D. Pittet, and S. Sena, Safer Homes, Stronger Communities: A Handbook for Reconstructing after Natural Disasters, Washington, DC, USA: World Bank, 2010.
2. United Nations Office for Disaster Risk Reduction (UNDRR), Sendai Framework for Disaster Risk Reduction 2015–2030, Geneva, Switzerland: United Nations, 2015.
3. D. Alexander, Principles of Emergency Planning and Management, Oxford, U.K.: Oxford University Press, 2002.
4. National Disaster Management Authority (NDMA), Government of India, National Disaster Management Plan, New Delhi, India, Latest Edition.
5. C. Emdad Haque and M. Q. Zaman, Disaster Risk Reduction: Methods, Approaches and Practices, New York, NY, USA: Springer, 2014.

Other Resources :

1. NPTEL: Satellite communication, Prof. Kalyan Kumar Bandyopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/117105131

2. NPTEL/SWAYAM: Climate Change — Science, Impacts & Extreme Events
https://onlinecourses.nptel.ac.in/noc25_ce135/preview

3. UDEMY: Advances in Disaster Management: Principles and Practices
https://www.udemy.com/share/10aBGu/

4. ISRO IIRS E-Learning: Geospatial Technology for Disaster Risk Reduction (GIS, RS & GPS)
https://elearning.iirs.gov.in/courses/paper_05/default.htm

5. **NDMA, Government of India – Policies, Guidelines & SOPs**
https://ndma.gov.in/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment-Theory (20 Marks)

Suggested breakup of distribution

a) Case studies: 10 Marks

c) Open book test/Class assignment: 05 Marks

d) Regularity and active participation: 05 Marks

2. Mid Semester Examination (30 Marks)

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

B. END SEMESTER EXAMINATION (50 MARKS)

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

Course Type	Course Code	Course Name	Credits
OEC	OEC8029	ENVIRONMENTAL MANAGEMENT	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. PO6 : The engineer & The World
2. PO7 : Ethics
3. PO10: Project Management and Finance

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Module	Details	Hrs.
00.	**Course Introduction**	**01**
01.	**Introduction and Definition of Environment**	**09-11**
	Contents: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
02.	**Global Environmental concerns**	**06-08**
	Contents: Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
03.	**Concepts of Ecology**	**05-07**
	Contents: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
	Environmental Management and Government Regulation	**10-12**

04.	**Contents:** Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
05.	**Quality-Based Environmental Management and ISO 14000 Framework**	**05-07**
	Contents: Total Quality Environmental Management, ISO-14000, EMS certification.	
06.	**Overview of Environmental and Industrial Legislations**	**02-04**
	Contents: General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
	Course Conclusion	**01**
	Total	**45**

Course Outcomes: Learner will be able to

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
OEC8029.1	--	--	--	--	--	3	3	--	--	3	--
OEC8029.2	--	--	--	--	--	3	3	--	--	--	--
OEC8029.3	--	--	--	--	--	3	3	--	--	3	--
Average	--	--	--	--	--	**3**	**3**	--	--	**3**	--

References:

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

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment – Theory (20 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
MJP	MJP802	MAJOR PROJECT-B	04

A. Guidelines for the Major Project-B

1. Project Continuation

- The project initiated in Semester VII (Major Project – A) continues in Semester VIII.
- Project Outcomes, Objectives, and POs remain the same.

2. Focus for Semester VIII

- This phase emphasizes completion, optimization, testing, performance evaluation, and deployment (where applicable).
- Students should work toward:
  - Prototype development/product readiness
  - Validation through experiments, benchmarking, or user trials
  - Technical documentation and dissemination (paper, poster, demonstration)

3. Research and Innovation Encouragement

- Teams are encouraged to:
  - Present papers in conferences/symposia/workshops
  - Participate in inter-college / national project competitions or hackathons
  - Submit project outcomes to innovation cells, incubation centres, etc.
- Such activities carry marks under In-Semester Continuous Assessment (CIA).

4. Project Execution and Supervision

- The guide continues to monitor weekly progress and maintain:
  - Work logs
  - Attendance
  - Contribution records
- The department's Project Progress Monitoring Committee shall evaluate at least two progress reviews during the semester.

5. Project Report (Final Submission)

The final project report must include:

- Revised/Final Abstract
- Literature Review (updated if needed)
- Final System Design, Implementation, and Architecture
- Experimental Setup and Evaluation Parameters
- Results with Comparative Analysis
- Discussion, Conclusion & Limitations
- Future Scope and Applications
- References (IEEE format preferred)
- Appendices (Certificates, Publications, Competition Participation, etc.)

B. In-Semester Continuous Assessment (CIA) — *Total: 50 Marks*

Component	Description	Marks
Progress Review Presentation I	Demonstration of implementation progress with clarity in design and execution	10
Progress Review Presentation II	Demonstration of testing, validation, and refinement; readiness for final deployment	10
Research / Innovation Activities	• Participation/winning in project competitions, hackathons, etc. • Technical paper writing/presentation/publication	05 10
Final Draft Report (Spiral/Soft Copy)	Quality of documentation, structure, clarity, proper referencing, and reflection of actual work	10
Regularity & Active Participation	Consistent attendance, timely submissions, teamwork, individual responsibility, and weekly log progress	05

C. End Semester Examination (ESE) — *Total: 50 Marks*

Examination by Internal + External Examiners

Component	Description	Marks
Project Demonstration / Prototype Performance	Functional correctness, performance, robustness, completeness of implementation	20
Oral Presentation and Defence	Clarity in explaining methodology, decisions, results, and the ability to answer technical questions	15
Project Report (Final Hard-Bound Submission)	Technical depth, coherence, experimental analysis quality, formatting standards, and completeness	10
Individual Contribution Assessment	Clear evidence of individual technical contribution and responsibility within the team	05

FCRIT Internship Policy Document for Semester VIII (AY 2026-27 Onward)

1. Preamble

In alignment with the autonomous curriculum framework and Outcome-Based Education (OBE) philosophy, Agnel Charities Fr. C. Rodrigues Institute of Technology (FCRIT) mandates one semester full-time Internship in Semester VIII, carrying 10 academic credits.

The internship is designed to provide structured experiential learning, industry exposure, professional skill development, and alignment with NBA Program Outcomes.

This policy governs all academic, administrative, ethical, and evaluation aspects of the Semester VIII Internship.

2. Objectives

The Semester VIII Internship aims to:

a) Bridge academic learning with real-world applications.
b) Develop technical, managerial, and professional competencies.
c) Enhance problem-solving and analytical abilities.
d) Promote industry–institute interaction.
e) Encourage multidisciplinary and multicultural exposure (India/Abroad).
f) Strengthen attainment of Program Outcomes (POs).

3. Scope and Applicability

This policy applies to:

- All Undergraduate Programs at FCRIT.
- All students registered in Semester VIII from AY 2026–27 onwards.
- Internships undertaken in India or Abroad.
- Technical, Research, Management, or Internal (FCRIT) internships.

4. Structure and Categories of Internship

The internship carries 10 credits and is conducted full-time during the eighth semester. The evaluation is divided equally between Continuous Internal Assessment (CIA) and End Semester Examination (ESE), each contributing 50 marks, making a total of 100 marks.

Categories of Internship

a) Core Technical Internship.
b) Research Internship.
c) Management/Operations Internship.
d) Start-up/Entrepreneurship Internship.
e) Internal Internship (within FCRIT – approved projects/labs).

5. Timeline

a) The process of application and confirmation by the students should be completed before the conclusion of semester VII ESE.
b) Completion certificate must be submitted before Semester VIII ESE.
c) Students must physically report to the FCRIT and appear for their ESE.

6. Conflict of Interest Declaration

Students must declare if the internship is in a family-owned or related organization.

7. Academic Integration

1) Other Semester VIII courses shall be delivered online in asynchronous mode.
2) CIA/MSE for other courses shall be conducted online.
3) Companies are required to release students during academic evaluations.

8. Roles and Responsibilities

8.1 Student

a) Secure an internship within the prescribed timeline and submit an internship offer letter to the HOD/Internship Coordinator for further approval.
b) Follow the instructions given by internal/external mentor, HOD, etc.
c) Follow workplace safety norms.
d) Maintain professional conduct.
e) Adhere to anti-harassment and anti-discrimination policies.
f) Comply with FCRIT Code of Conduct.
g) Follow company/FCRIT rules and professional ethics.
h) Maintain a weekly logbook and appear for CIA by external and internal mentors as and when asked.
i) Submit the internship report and completion certificate before the given deadline.
j) Students facing any problem may report to either to the Internal Mentor or HoD or Internship Committee.

8.2 Internship Committee (Department Level)

Each Department shall constitute Internship Committee involving:

- HoD (Chair).
- Internship Coordinator.
- One or Two Senior Faculty Members.
- TPO Representative.

Responsibilities:

- Approve internships after verifying the offer letter and assessing the requirement for an NDA.
- Assign zone-wise or city-wise internal mentors (Not applicable for foreign internship).
- Monitor overall progress.

- Address grievances.
- Ensure policy compliance.
- Collecting an 'Undertaking' from all the parents in the prescribed format before the internship begins.

8.3 Internal Mentor

- Conduct CIA reviews and ESE and enter marks in the APMS portal.
- Visit the company and interact with the external mentor in offline mode at least once (Not applicable for foreign internship).
- Monitor academic compliance.
- Map internship performance to POs/SDGs.
- Consent and compliance for publication work from the external mentor.

8.4 External Mentor

- Assign structured tasks.
- Provide guidance and performance feedback.
- Certify attendance and completion.
- Issue completion certificate.

8.5 TPO – FCRIT

- Facilitate the acquisition of industry internships.
- Issue application letters upon request.
- Maintain internship records.
- Facilitate industry coordination.
- Encourage MoUs.

09. Internship Logbook

- Weekly entries mandatory.
- Must include tasks, tools, learning outcomes, and challenges.
- Verified by External and Internal Mentors.
- Reviewed during CIA.

10. International Internship Guidelines

Student shall be responsible for:

- Visa, travel compliance, stay, etc.
- Insurance.
- Safety adherence.
- Time-zone coordination for CIA/ESE.

All documents must be approved before departure.

11. Evaluation Scheme

11.1 Continuous Internal Assessment (CIA) – 50 Marks

a) Based on progressive improvement.
b) Minimum 3 to 4 presentations/reviews.
c) Conducted independently by Internal and External Mentors.
d) The CIA will be based on multiple criteria, including the student's understanding of the problem, depth of technical knowledge demonstrated, consistency and quality of work progress, effectiveness of communication, and overall professionalism displayed during the internship.

11.2 End Semester Evaluation (ESE) – 50 Marks

a) Internship Report Submission.
b) 15-minute Presentation.
c) Viva Voce.
d) Mode: Online/Offline.
e) Evaluation by Internal + External Mentor or Senior Internal Mentor.
f) ESE Rubric:

Component	Marks
Report Quality	15
Technical Depth	10
Practical Implementation	10
Presentation	5
Viva Voce	10

12. Internship Cancellation Policy

Internship may be cancelled in case of:

- Misconduct.
- Breach of confidentiality.
- Fraudulent documentation.
- Persistent non-performance.

Disciplinary procedure shall be initiated by the Department Internship Committee.

13. Non-Completion Clause

Internship shall be declared incomplete if:

- Duration is less than the prescribed period.
- CIA/ESE requirements not fulfilled.
- Completion certificate not submitted.

The student must re-register and repeat the internship.

14. Plagiarism and Academic Integrity

- Report similarity index must be <15%.
- Fabrication of data leads to failure.

15. Effective Date

This policy shall be effective from Academic Year 2026–27 and applicable to all students admitted under autonomous framework.

Dr. S. M. Khot
(Principal)