BABU BANARASI DAS UNIVERSITY
School of Engineering
(School Code: 04) (University Branch Code: 38)
Department of Computer Science and Engineering
Bachelor of Technology: Computer Science and Engineering
(Cloud Computing and Machine Learning) (In association with IBM)

Evaluation Scheme

SEMESTER I

Course Category	Course Code	Course Title	Contact Hours			Evaluation Scheme			Credit
			L	T	P	CIA	ESE	Total	
BSC	RBS5103	Calculus	3	1	0	40	60	100	4
PCC	RCCML5101	Introduction to Python Programming and Clean Coding	3	0	0	40	60	100	3
PCC	RCCML5151	Python Programming and Clean Coding Lab	0	0	2	40	60	100	1
GP	RGP5101	General Proficiency	-	-	-	100	-	100	1
Total			**6**	**1**	**2**	**220**	**180**	**400**	**9**

Students need to select either GROUP 'A' or GROUP 'B'

GROUP'A'

Course Category	Course Code	Course Title	Contact Hours			Evaluation Scheme			Credit
			L	T	P	CIA	ESE	Total	
BSC	RBS5101	Quantum Physics and Advanced Functional Materials	3	1	0	40	60	100	4
ESC	RME5101	Engineering Mechanics and Mechatronics	3	1	0	40	60	100	4
ESC	REC5101	Basic Electronics Engineering	3	0	0	40	60	100	3
BSC	RBSA5103	Environment & Ecological Sustainability	2	1	0	40	60	100	3
ESC	RME5151	Engineering Mechanics and Mechatronics Lab	0	0	2	40	60	100	1
ESC	RME5153	Workshop Practices	0	0	2	40	60	100	1
BSC	RBS5151	Quantum Physics and Advanced Functional Materials Lab	0	0	2	40	60	100	1
Total			**11**	**3**	**6**	**280**	**420**	**700**	**17**

GROUP 'B'

Course Category	Course Code	Course Title	Contact Hours			Evaluation Scheme			Credit
			L	T	P	CIA	ESE	Total	
ESC	REE5101	Electrical Engineering Concepts	3	1	0	40	60	100	4
BSC	RBS5102	Sustainable Chemical Sciences	3	1	0	40	60	100	4
BSC	RHSA5101	Professional and Workplace Communication	2	1	0	40	60	100	3
ESC	RCS5102	Basics of Artificial Intelligence	3	0	0	40	60	100	3
ESC	REE5151	Electrical Engineering Lab	0	0	2	40	60	100	1
BSC	RBS5152	Sustainable Chemical Sciences Lab	0	0	2	40	60	100	1
ESC	RME5152	Engineering Graphics Lab	0	0	2	40	60	100	1
Total			**11**	**3**	**6**	**280**	**420**	**700**	**17**

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SEMESTER II								
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Total**	
BSC	RBS5203	Discrete Mathematics	3	1	0	40	60	100	4
PCC	RCCML5202	Introduction to Java Programming	3	0	0	40	60	100	3
PCC	RCCML5252	Java Programming Lab	0	0	2	40	60	100	1
GP	RGP5201	General Proficiency	-	-	-	100	-	100	1
Total			**6**	**1**	**2**	**220**	**180**	**400**	**9**
Students need to select either GROUP 'A' or GROUP 'B'									

GROUP'A'									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Total**	
BSC	RBS5201	Quantum Physics and Advanced Functional Materials	3	1	0	40	60	100	4
ESC	RME5201	Engineering Mechanics and Mechatronics	3	1	0	40	60	100	4
ESC	REC5201	Basic Electronics Engineering	3	0	0	40	60	100	3
BSC	RBSA5203	Environment & Ecological Sustainability	2	1	0	40	60	100	3
ESC	RME5251	Engineering Mechanics and Mechatronics Lab	0	0	2	40	60	100	1
ESC	RME5253	Workshop Practices	0	0	2	40	60	100	1
BSC	RBS5251	Quantum Physics and Advanced Functional Materials Lab	0	0	2	40	60	100	1
Total			**11**	**3**	**6**	**280**	**420**	**700**	**17**
GROUP 'B'									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
ESC	REE5201	Electrical Engineering Concepts	3	1	0	40	60	100	4
BSC	RBS5202	Sustainable Chemical Sciences	3	1	0	40	60	100	4
BSC	RHSA5201	Professional and Workplace Communication	2	1	0	40	60	100	3
ESC	RCS5202	Basics of Artificial Intelligence	3	0	0	40	60	100	3
ESC	REE5251	Electrical Engineering Lab	0	0	2	40	60	100	1
BSC	RBS5252	Sustainable Chemical Sciences Lab	0	0	2	40	60	100	1
ESC	RME5252	Engineering Graphics Lab	0	0	2	40	60	100	1
Total			**11**	**3**	**6**	**280**	**420**	**700**	**17**

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SEMESTER III									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
HSMC	RHS5301 / RHS5302	Work and Organizational Psychology in the Digital Age/Sociology of Work, Technology and Innovation	1	1	0	40	60	100	2
RBS	RBS5303	Linear Algebra	3	1	0	40	60	100	4
MC	RMC5311	Startup and Innovation	2	0	0	40	60	100	2
PCC	RCS5301	C Programming	3	1	0	40	60	100	4
PCC	RAI5302	Database Management Systems	3	1	0	40	60	100	4
PCC	RCCML5301	Fundamentals of Data Science	2	1	0	40	60	100	3
PCC	RCS5351	C Programming Lab	0	0	2	40	60	100	1
PCC	RAI5352	Database Management Systems Lab	0	0	2	40	60	100	1
PCC	RCCML5351	Data Science Lab	0	0	2	40	60	100	1
MC	RMC5351	YOGA Activities	0	0	2	100	-	100	1
GP	RGP5301	General Proficiency	-	-	-	100	-	100	1
Total			**14**	**5**	**8**	**560**	**540**	**1100**	**24**

SEMESTER IV									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
HSMC	RHS5402/ RHS5401	Sociology of Work, Technology and Innovation/Work and Organizational Psychology in the Digital Age	1	1	0	40	60	100	2
RBS	RBS5403	Probability & Statistics	3	1	0	40	60	100	4
PCC	RAIBC5401	Big Data Analytics and Architecture	3	1	0	40	60	100	4
PCC	RCCML5402	Cloud Computing	3	0	0	40	60	100	3
PCC	RCS5404	Operating Systems	3	1	0	40	60	100	4
PCC	RCS5403	Data Structures using ‘C’	3	1	0	40	60	100	4
PCC	RCCML5452	Cloud Computing Lab	0	0	2	40	60	100	1
PCC	RCS5454	Operating Systems Lab	0	0	2	40	60	100	1
PCC	RCS5453	Data Structure Using ‘C’ Lab	0	0	2	40	60	100	1
MC	RMC5401	Indian Constitution	1	0	0	40	60	100	1
GP	RGP5401	General Proficiency	-	-	-	100	-	100	1
Total			**16**	**5**	**6**	**500**	**600**	**1100**	**26**

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SEMESTER V									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
HSMC	RHS5501	AI Economy and Digital Innovation	2	1	0	40	60	100	3
MC	RMC5501	Essence of Indian Knowledge Tradition	1	0	0	40	60	100	1
PCC	RCS5501	Automata Theory and Formal Languages	3	1	0	40	60	100	4
PCC	RCS5505	Predictive Analytics	3	1	0	40	60	100	4
PCC	RCCML5501	DevOps	2	1	0	40	60	100	3
PCC	RCS5502	Computer Networks	2	1	0	40	60	100	3
PCC	RCS5555	Predictive Analytics Lab	0	0	2	40	60	100	1
PCC	RCCML5551	DevOps Lab	0	0	2	40	60	100	1
PCC	RCS5552	Computer Networks Lab	0	0	2	40	60	100	1
PSI	RCCML5555	Seminar	0	0	2	100	-	100	1
PSI	RCCML5553	Minor Project-I	0	0	2	100	-	100	1
GP	RGP5501	General Proficiency	-	-	-	100	-	100	1
Total			**13**	**5**	**10**	**660**	**540**	**1200**	**24**

SEMESTER VI									
Course Categor	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
HSMC	RHS5601	Industrial Management	2	1	0	40	60	100	3
PEC	(RPEC53811-14)	**Professional Elective Course-I**	2	1	0	40	60	100	3
PEC	(RPEC53821-24)	**Professional Elective Course-II**	2	1	0	40	60	100	3
PCC	RCS5604	Compiler Design	3	1	0	40	60	100	4
PCC	RCCML5601	Machine Learning	3	1	0	40	60	100	4
PCC	RCS5603	Design and Analysis of Algorithms	3	1	0	40	60	100	4
PCC	RCCML5651	Machine Learning Lab	0	0	2	40	60	100	1
PCC	RCS5653	Design and Analysis of Algorithms Lab	0	0	2	40	60	100	1
PSI	RCCML5652	Minor Project-II	0	0	2	100	-	100	1
GP	RGP5601	General Proficiency	-	-	-	100	-	100	1
Total			**15**	**6**	**6**	**520**	**480**	**1000**	**25**

Note: The students need to undergo a 4 to 6 weeks of industrial training that will be evaluated in the VII Semester.

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SEMESTER VII									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
PCC	RCS5703	AI Ethics	2	0	0	40	60	100	2
PEC	(RPEC53831-34)	**Professional Elective Course-III**	2	1	0	40	60	100	3
OEC		**Open Elective I***	3	1	0	40	60	100	4
PCC	RCCML5701	Concepts of Deep Learning	3	1	0	40	60	100	4
PCC	RCCML5751	Deep Learning Lab	0	0	2	40	60	100	1
PSI	RCCML5753	Major Project I#	0	0	8	100	-	100	4
PSI	RCCML5754	Industrial Training Evaluation	0	0	4	100	-	100	2
GP	RGP5701	General Proficiency	-	-	-	100	-	100	1
Total			**10**	**3**	**14**	**500**	**300**	**800**	**21**

*Students will opt any one of the open electives from the list of open electives provided by the University.

#Students need to submit an abstract for the project, select a guide and will complete the literature review related to the project.

SEMESTER VIII									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
PEC	RPEC53841-44	**Professional Elective Course IV**	2	1	0	40	60	100	3
OEC		**Open Elective II****	3	1	0	40	60	100	4
PCC	RCS5801	Cyber Security and Computer Forensics	3	1	0	40	60	100	4
PSI	RCCML5851	Major Project II##	0	0	16	160	240	400	8
GP	RGP5801	General Proficiency	-	-	-	100	-	100	1
Total			**8**	**3**	**16**	**380**	**420**	**800**	**20**

**The opted subject should be different from the one selected in VII Semester.

##This is in continuation with the project work started in Semester VII. In this semester the students will formulate the methodology do experimentation and show the results. Finally, all project work will be presented in a report i.e. Project Report.

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List of Professional Elective Courses

#	Course Code	Professional Elective Course I	Credit
1	RPEC53811	Deployment of Private Cloud	3
2	RPEC53812	Cloud Native	3
3	RPEC53813	Evolutionary Algorithms	3
4	RPEC53814	Internet of Things	3
#	**Course Code**	**Professional Elective Course II**	**Credit**
1	RPEC53821	Network Security and Cryptography	3
2	RPEC53822	Cloud Security	3
3	RPEC53823	Robotics	3
4	RPEC53824	Fuzzy Logic	3

#	Course Code	Professional Elective Course III	Credit
1	RPEC53831	Artificial Neural Network	3
2	RPEC53832	Computer Vision	3
3	RPEC53833	Data Visualization and Statistics	3
4	RPEC53834	No SQL and MongoDB	3

#	Course Code	Professional Elective Course IV	Credit
1	RPEC53841	Essentials of Blockchain Technology	3
2	RPEC53842	Data Compression	3
3	RPEC53843	Bioinformatics	3
4	RPEC53844	Pattern Recognition	3

List of Open Electives Offered by the Department of Computer Science and Engineering

#	Course Code	Open Elective I	Credit
1	OE53101	Disaster Management	4
2	OE53201	Database Administration	4
3	OE53501	Quality Management	4
4	OE53301	Energy Management	4
#	**Course Code**	**Open Elective II**	**Credit**
1	OE53102	Concepts of Climate Smart Agriculture	4
2	OE53202	Computational Intelligence	4
3	OE53502	Product Development	4
4	OE53302	Non-Conventional Energy Resources	4

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List of Vocational Courses Offered by the Department of Computer Science and Engineering

#	Course Code	Vocational Courses	Credit
1	NVC53811	Programming with Python	2
2	NVC53812	Fundamentals of Artificial Intelligence	2
3	NVC53813	Cyber Crime and Computer Forensics	2
4	NVC53814	Meta-verse and Virtual Reality	2

Course Code and Definitions

Code	Definition
L	Lecture
T	Tutorial
P	Practical
CIA	Continuous Internal Assessment
ESE	End Semester Examination
BSC	Basic Science Courses
PCC	Professional Core Courses
ESC	Engineering Science Courses
PEC	Professional Elective Course
GP	General Proficiency
HSMC	Humanities, Social Science, and Management Courses
OE	Open Elective
PSI	Project/Seminar/ Internship
MC	Mandatory Course
VC	Vocational Course

Program	B. Tech. CSE (CCML)				
Year	I	**Semester**	I		
Course Name	Introduction to Python Programming and Clean Coding				
Code	RCCML5101				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Programming Skills	3	0	0	3
Course Objectives	1. To understand why Python is a useful scripting language for developers. 2. To learn how to design and program Python applications. 3. To learn how to use lists, tuples, and dictionaries in Python programs. 4. To learn how to identify Python object types.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the Writing of loops and decision statements in Python.				
CO2	Analyze and Build package of Python modules for reusability.				
CO3	Students will apply object-oriented principles to develop structured programs and manage data using file operations. They will also handle exceptions gracefully to create robust and error-resilient applications.				
CO4	Students will use Python libraries like Matplotlib to analyze and visualize data, and integrate real-time data using REST APIs. They will apply all concepts in a mini project demonstrating end-to-end application development.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Python:** History and features of Python. Python installation and IDEs: IDLE, VS Code, Jupyter, Basic syntax, keywords, and data types. Variables and constants. Operators: Arithmetic, Relational, Logical, Assignment, Bitwise. Input/output functions. Type conversion and typecasting. Basic programs and debugging.	15 Hours	CO1
2	**Control Structures and Functions:** Conditional statements: if, if-else, if-elif-else, Loops: for, while, break, continue, pass. Range and list comprehension. Functions: definition, calling, arguments, return values. Types of functions: built-in, user-defined, lambda.Variable scope: local, global, *args, **kwargs, Recursion, Modules and packages (introduction).	15 Hours	CO2
3	**Data Structures and File Handling:** Strings and string operations. Lists, Tuples, Sets, Dictionaries: creation, methods, use cases. Iteration over collections. File handling: opening, reading, writing, and appending. Working with text and binary files. Exception handling: try, except, finally, raise. The with statement. **Object-Oriented Programming and Libraries:** OOP concepts: class, object, in it, self, attributes and methods, Inheritance and polymorphism, Method overriding and overloading, Encapsulation and abstraction. Introduction to libraries: math, random, date-time, os, sys Brief introduction to NumPy, pandas, and matplotlib.	15 Hours	CO3, CO4

Suggested Readings:

1. M. Lutz, Learning Python, Sebastopol, CA, USA: O'Reilly Media,2013(5th Edition).
2. J. Ernesti and P. Kaiser, Python 3: The Comprehensive Guide, Boston, MA, USA: Rheinwerk Publishing (SAP Press), 2022(1st Edition).
3. B. Slatkin, Effective Python: 125 Specific Ways to Write Better Python, *Boston*, MA, USA: Addison-Wesley Professional, Nov. 2024(3rd Edition).
4. R. C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, Upper Saddle River, NJ, USA: Prentice Hall, 2008(1st Edition).

Online Resources:

1) https://archive.nptel.ac.in/courses/106/106/106106182/

Course Articulation Matrix													
PO- PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3	2	2	1	1						1	3	
CO 2	3	1	2	2	3						2	2	3
CO 3	2	2	1		1						1	2	2
CO 4	3	3	3	1	2						2	3	3

Program	B. Tech CSE (CCML)					
Year	I	**Semester**	I			
Course Name	Python Programming and Clean Coding Lab					
Code	RCCML5151					
Course Type	PCC		**L**	**T**	**P**	**Credit**
Pre-Requisite	Basics of Python Programming		0	0	2	1
Course Objectives	1. To read and write simple Python programs. 2. To develop Python programs with conditionals and loops. 3. To define Python functions and to use Python data structures – lists, tuples, and dictionaries. 4. To do input/output with files in Python.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Understand the concepts of Python Programming.					
CO2	Analyze the syntax and structures of Python Programming.					
CO3	Understanding project-based development.					
CO4	Apply what you've learned to gain a better understanding of Python Programming.					

S. No.	Course Contents	Mapped CO
1	Write a Python program that takes two numbers as input from the user and displays the result of all arithmetic operations (addition, subtraction, multiplication, division, modulus, exponent, and floor division).	CO1
2	Write a program that accepts a user's name and age, then prints a message displaying the user's name in uppercase and calculates the year they will turn 100.	CO1
3	Create a program that checks whether an entered number is positive, negative, or zero using conditional statements.	CO2
4	Write a function that returns the factorial of a number using recursion. Ask the user to input a number and call the function.	CO2
5	Write a program that takes a list of integers and returns a new list using list comprehension that contains only the even numbers.	CO2
6	Write a Python script to count the number of vowels, consonants, digits, and special characters in a given string.	CO3
7	Create a dictionary to store student names and their marks. Write a program to display the highest, lowest, and average marks.	CO3
8	Write a program to read a text file, count the number of words, and write the result to a new file. Use exception handling to manage file errors.	CO3
9	Create a class Bank Account with attributes account holder and balance. Add methods to deposit, withdraw, and display the balance. Demonstrate the usage of inheritance by creating a Savings Account subclass that has an additional attribute for interest rate.	CO4
10	Write a Python program using the random, math and datetime libraries to generate:	CO4

	• A random number between 1 and 100, • The square root of the number, • And the current date and time when the operation was performed.	
11	**Project Statement** Design and develop a Python-based console application that manages student academic records. The system should allow users to add student information, record subject-wise marks, compute total and average scores, assign grades, and generate individual report cards. It should also support saving and retrieving data using a file handling technique.	CO4

Suggested Readings:

1. M. Lutz, Learning Python, Sebastopol, CA, USA: O'Reilly Media,2013(5th Edition).
2. J. Ernesti and P. Kaiser, Python 3: The Comprehensive Guide, Boston, MA, USA: Rheinwerk Publishing (SAP Press), 2022(1st Edition).
3. B. Slatkin, Effective Python: 125 Specific Ways to Write Better Python, *Boston*, MA, USA: Addison-Wesley Professional, Nov. 2024(3rd Edition).

R. C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, Upper Saddle River, NJ, USA: Prentice Hall, 2008(1st Edition)

Online Resources:

1. https://numpy.org/doc/stable/
2. https://pandas.pydata.org/docs/
3. https://matplotlib.org/stable/tutorials/index.html
4. https://scikit-learn.org/stable/user_guide.html

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3	3	2	2	3					1		3	2
CO 2	2	2	2	2	3					1	1	3	2
CO 3	2	2	3	3	3					2		3	3
CO 4	3	3	3	3	3	2				2	1	3	3

Program	B.Tech (CSE-CCML)				
Year	I	**Semester**		I/II	
Course Name	Engineering Mechanics and Mechatronics				
Code	RME5101/RME5201				
Course Type	ESC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Knowledge Physics and Mathematics	3	1	0	4
Course Objectives	1. To understand force systems, equilibrium conditions, and free body diagrams for engineering mechanics analysis. 2. To understand beam mechanics, support reactions, and friction principles in engineering systems. 3. To understand centroid, moment of inertia, stress, strain, and their applications in engineering mechanics. 4. To understand measurement techniques, instrumentation systems, sensors, and mechatronics applications in engineering.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Analyze equilibrium equations to solve engineering mechanics problems.				
CO2	Analyze beams, calculate support reactions, and solve friction-related problems.				
CO3	Determine centroid and moment of inertia of bodies and analyze stress–strain behavior of materials.				
CO4	Use of measurement instruments, analyze errors, and understand sensors and mechatronic systems.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Force Systems:** Concurrent and Non-concurrent forces, laws of motion, principle of transmissibility of forces. Resultant of concurrent force system. Resultant of non-concurrent force system. **Equilibrium of Force Systems:** Free body diagram. Equations of equilibrium and its applications.	15 Hours	CO1
2	**Equilibrium and Beam Mechanics:** Introduction, Types of support, Types of load on beam, Types of beam, Reactions from supports of beam. **Friction:** Introduction, Laws of Coulomb Friction, equilibrium of Bodies involving dry friction, Belt friction and its application.	15 Hours	CO2
3	**Centroid and Moment of Inertia:** Centroid of plane and composite figure, Moment of inertia of plane area, Parallel axes theorem. Perpendicular axes theorem, moment of inertia of composite bodies. **Simple Stress and Strain:** Normal and Shear stresses, Stress-Strain Diagrams for ductile and brittle material, Elastic Constants, One Dimensional Loading of members.	15 Hours	CO3

4	**Measurement & Instrumentation:** Concept of measurement. Errors in measurement and calibration. Pressure measurement, temperature measurement, force measurement. Torque measurement. **Mechatronics:** Introduction and evolution of mechatronics, scope, advantages and disadvantages, elements of mechatronic systems, sensors and transducers and their characteristics, actuators, open-loop and closed-loop control systems, industrial automation, robotics, smart manufacturing and applications of mechatronics in modern engineering systems.	15 Hours	CO4

Suggested Reading:

1. S. S. Bhavikatti and K. G. Rajashekarappa, Engineering Mechanics, 6th Ed., New Age International Publishers, New Delhi, 2018.
2. R. K. Bansal, A Textbook of Strength of Materials (In S.I. Units), 6th Ed., Laxmi Publications Pvt. Ltd., New Delhi, 2018.
3. R. K. Rajput, A Textbook of Measurements & Metrology, 1st Ed., S. K. Kataria & Sons, New Delhi, 2012.
4. Beckwith, Marangoni and Lienhard, Mechanical Measurements, 6th Ed., Pearson Education, 2007.

Online Resources:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me27
2. https://nptel.ac.in/courses/112106286?.com

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	2	1	-	-	-	1	-	-	1	1
CO2	3	3	2	2	1	-	-	-	1	-	-	1	1
CO3	3	3	2	2	1		-	-	-	-	-	1	1
CO4	3	2	2	2	3		1		1		-	2	3

Program	B. Tech CSE (CCML)					
Year	I	Semester	I/II			
Course Name	Basic Electronics Engineering					
Course Code	REC5101/REC5201					
Course Type	ESC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Knowledge of Physics and Mathematics	3	0	0	3	
Course Objectives	1. Basic Idea of Semiconductor Physics.					
	2. Comprehensive Idea of Basic Electronic devices like (Diode, BJT and JFET)					
	3. Fundamental Principle of Operational Amplifier and Its Application					
	4. To have an Idea about Digital Electronics.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Understanding the Basic concept of semiconductor material (N type and P type), fundamentals of electronic Devices like Diode and its application as Rectifier, Light Emitting Diode, Photo Diode and Varactor Diode.					
CO2	Analyzing the fundamentals of electronic devices like BJT and JFET.					
CO3	Understanding the principles of Operational Amplifier and its application.					
CO4	Evaluate the Number system, Boolean algebra, logic gates.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**DIODES:** Energy Band theory, Semiconductor material, Law of Mass Action, PN junction Diode and its biasing, V-I characteristics of Practical and Ideal Diode, Diode as Rectifier: Half and Full wave Rectifiers, Breakdown Mechanism: Zener and Avalanche breakdown mechanism, Zener Diode and its application, Special purpose Diodes: Light Emitting Diode, Photo Diode, Varactor Diode.	15 Hours	CO1
2	**TRANSISTORS:** Transistor construction, Transistor types and its working, Base-Width modulation (Early Effect), Thermal Runaway, BJT configurations: CE, CB and CC, Input and Output characteristics of CB & CE configuration, Biasing: Fixed bias, Emitter bias, Potential divider bias, Collector feedback bias. Transistor Amplifying Action. **JFET:** Basic construction and working of JFET, Drain and transfer characteristics, Biasing: Self bias, fixed bias and Voltage divider bias.	15 Hours	CO2
3	**OPERATIONAL AMPLIFIER AND DIGITAL ELECTRONICS:** Introduction to OP-AMP, Equivalent Circuit and Pin diagram of Op-amp IC741, Characteristics of ideal OP-AMP, Input Offset Current, Input Bias Current, Configurations: Open loop and closed loop, Applications of OP-AMP: Inverting amplifier, Non-inverting amplifier, Voltage follower, summing amplifier, Difference Amplifier, Integrator and Differentiator. Number System, Complements, Subtraction of binary number using l's and 2's Complements, BCD Code, Excess-3 code, Gray code (Cyclic Code). Boolean Algebra: Basic Theorems, Demorgan's theorem, Standard logic Gates, Universal logic gates. Implementation of Boolean Function using Basic and Universal logic gates.	15 Hours	CO3, CO4

Suggested Readings

1. Robert L. Boylestad and Louis Nashelsky Electronic Devices and Circuit Theory, Pearson India, 11th edition 2013.
2. M. Morris Mano, Digital Logic and Computer Design, PHI, 3rd edition,2004.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc21_ee55/preview

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	1	1	1	2								
CO2	1	1	1	1	1								
CO3	1	1	3	3	3								
CO4	1	2	1	1	3								

Program	B. Tech CSE (CCML)					
Year	I	**Semester**	I/II			
Course Name	Engineering Mechanics and Mechatronics Lab					
Course Code	RME5151/RME5251					
Course Type	ECS	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic Knowledge Physics and Mathematics	0	0	2	1	
Course Objectives	1. Develop practical understanding of friction, force systems, beam behavior, flywheel dynamics, and mechanical power transmission mechanisms through laboratory experimentation.					
	2. Investigate and evaluate the mechanical properties of engineering materials and machine elements using standard testing methods.					
	3. Understand principles of engineering measurements, instrumentation, error analysis, and calibration techniques.					
	4. Familiarize students with basic mechatronics concepts, open-loop and closed-loop control systems, and their engineering applications.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Perform experiments related to friction, beam deflection, worm gear mechanisms, and flywheel systems and interpret the obtained results.					
CO2	Analyze the mechanical properties of materials under tensile and impact loading using standard testing procedures and compare experimental and theoretical results.					
CO3	Evaluate measurement accuracy, precision, resolution, errors, and apply basic instrumentation concepts in engineering measurements.					
CO4	Differentiate between open-loop and closed-loop control systems and explain their applications in mechatronic engineering systems.					

S. No.	List of Experiments	Mapped CO
1	Experimental analysis of frictional behavior of a block on inclined plane.	CO1
2	Experimental analysis of frictional behavior in a screw Jack.	CO1
3	Experimental analysis of worm gear mechanism.	CO1
4	Experimental analysis of beam deflection.	CO1
5	Experimental analysis and strength prediction under tensile loading.	CO2
6	Experimental analysis of Impact toughness using Izod testing method.	CO2
7	Experimental analysis of Impact toughness using Charpy method.	CO2

8	Experimental and analytical Method to determine Moment of Inertia of a Flywheel.	CO2
9	Study of errors, accuracy, precision and resolution.	CO3
10	Study of open-loop and closed-loop control systems.	CO4

Suggested Reading:

1. R. K. Jain, Mechanical and Industrial Measurements, 17th Ed., Khanna Publishers, New Delhi, 2017.
2. V. D. Kodgire and S. V. Kodgire, Material Testing Laboratory Manual, Everest Publishing House, Latest Edition. 2008
3. T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard V, Mechanical Measurements, 6th Ed., Pearson Education, 2007.

Online Resources:

1. https://www.vlab.ac.in
2. https://nptel.ac.in
3. https://mechlab.iitkgp.ac.in

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	3	2							1	1
CO2	3	3	2	3	1							1	1
CO3	3	2	1	2	3							1	1
CO4	2	2	1	2	3							2	3

Program	B. Tech CSE (CCML)					
Year	I	**Semester**	I/II			
Course Name	Workshop Practices					
Course Code	RME5153/RME5253					
Course Type	ESC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Elementary understanding of engineering materials and manufacturing processes	0	0	2	1	
Course Objectives	1. Develop fundamental knowledge of tools, equipment, materials, and processes used in car 2. Pantry, fitting, welding, machining, sheet metal, black-smithy, and foundry shops. 3. Impart hands-on skills in performing manufacturing operations such as cutting, shaping, joining, forming, machining, and casting. 4. Enhance safety awareness, precision, workmanship, and professional ethics while working in workshop environments.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Identify, select, and safely operate workshop tools, equipment, and machines used in various manufacturing processes.					
CO2	Perform basic workshop operations including carpentry, fitting, welding, black-smithy, machining, sheet metal work, and foundry practices with acceptable accuracy.					
CO3	Fabricate simple engineering components, joints, and assemblies by applying appropriate workshop techniques and manufacturing processes.					
CO4	Demonstrate professional work practices, safety procedures, quality consciousness, and teamwork during workshop activities.					

S. No.	List of Experiments	Mapped CO
1	**Carpentry Shop-I:** Study of carpentry tools, equipment, safety practices and basic operations.	CO1
2	**Carpentry Shop-II:** Preparation of half-lap corner joint and mortise-tenon joint.	CO1
3	**Fitting Shop:** Study of fitting tools and operations; preparation of male-female fitting joint using drilling and tapping operations.	CO2
4	**Black Smithy Shop:** Study of tools and operations; exercises involving upsetting, drawing down, bending, punching, fullering and swaging.	CO2
5	**Welding Shop:** Study of gas welding and arc welding equipment; preparation of butt and lap joints.	CO3
6	**Sheet Metal Shop:** Study of sheet metal tools and operations; fabrication of funnel with soldering.	CO3
7	**Sheet Metal Shop-II:** Fabrication of tray, tool box or electrical	CO3

	panel box.	
8	**Machine Shop:** Study of machine tools and operations; plane turning, step turning and taper turning.	CO4
9	**Machine Shop-II:** Thread cutting and grinding of cutting tools.	CO4
10	**Foundry Shop:** Study of foundry tools, pattern making, mould preparation, pouring and casting operations.	CO4

Suggested Reading:

1. S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, 7th Ed., Pearson Education, New York, 2014.
2. H. S. Bawa, Workshop Practice, Tata McGraw-Hill Education, New Delhi, 2009.
3. K. C. John, Engineering Workshop Practice, 2nd Ed., PHI Learning Pvt. Ltd., New Delhi, 2010. Online Resources

Online Resources:

1. https://www.vlab.co.in
2. https://nptel.ac.in
3. https://spoken-tutorial.org
4. http://msvs1-dei.vbalbs.ac.in

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	1	3							1	
CO2	3	2	3	2	3							1	
CO3	3	3	3	2	2							1	
CO4	2	1	1	1	2							1	

Program	B.Tech CSE (CCML)				
Year	I	**Semester**	I/II		
Course Name	Electrical Engineering Concepts				
Code	REE5101/REE5201				
Course Type	ESC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Physics and Electrical Concepts	3	1	0	4
Course Objectives	1. To provide fundamental knowledge of electrical circuits, network analysis, and AC/DC systems for smart engineering applications. 2. To develop analytical and problem-solving skills using electrical laws, circuit theorems, and modern computational techniques. 3. To introduce electrical measuring instruments, transformers, smart grids, and electrical safety concepts used in modern power systems. 4. To understand the working and applications of electrical machines, electric vehicles, and intelligent energy systems through case studies and simulations.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply electrical circuit laws, network theorems, and analytical techniques to solve electrical engineering problems.				
CO2	Analyze AC/DC circuits, three-phase systems, and power measurements for smart electrical applications.				
CO3	Explain the operation and performance of electrical instruments, transformers, smart grids, and electrical safety systems.				
CO4	Analyze electrical machines, electric vehicle systems, and modern energy applications using simulation and case-study-based approaches.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Smart Electrical Circuits & Network Analysis: Fundamental elements: linear and nonlinear.** The study of various electrical sources and source transformation techniques. Kirchhoff's Law, mesh Law, Star/delta transformation and nodal analysis and their applications-based problem/case study simulation. Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer theorem and their application-based problem/case study simulation.	15 Hours	**CO1 CO2**

2	**AC Circuits & Smart Power Systems: F**undamentals of alternating quantities, Peak factor, Form factor, Power factor, Average and RMS values with significance. Phase, phase difference and associated problems. Study of different single phase AC circuits, power triangle (active power, reactive power and apparent power). Need of three phase systems. Measurement of three phase power by two wattmeter method.	15 Hours	**CO2**
3	**Electrical Measuring Instruments:** Essential components of indicating instruments, Smart permanent magnet moving coil instruments, moving iron instruments, Dynamometer wattmeter and Energy meter. **Power System:** Single line diagram, Smart grid and case study simulation. Magnetic Circuit, B-H Curve, Eddy Current loses Self and mutual Inductance. Single phase Transformer, EMF Equation, Equivalent circuit diagram, Efficiency, All Day Efficiency and loses. Auto Transformer, Advantages/Disadvantages and comparison with single phase transformer. Simulate a case study regarding cooling of transformer. **Earthing and Electrical Safety:** Earthing/Grounding, Equipment/Building Grounding, Electrical Hazards, Safety rules, Electrical injuries.	15 Hours	CO3
4	**Smart Electrical Machines Applications:** Basic concept of rotating machines, DC Machines (Motor/Generator), Three phase induction motor, Single phase induction motor (Double-field revolving theory, Starting methods), Synchronous generator, three phase Synchronous motor (V Curve and applications), Electric vehicles Vs. hybrid vehicles. **Components of EV:** Batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs, HEV drive train components and advantages.	15 Hours	CO4

Suggested Readings:

1. Charles K. Alexander and Matthew N. O. Sadiku ; Fundamentals of Electric Circuits; McGraw-Hill's 2020.
2. Vincent Del Toro; Electrical Engineering Fundamentals; Englewood Cliffs, NJ : Prentice-Hall; 1986.
3. D. P. Kothari, I. J. Nagrath, and A. K. Mittal; Basic Electrical Technology; McGraw-Hill; 2010.
4. V.K. Maurya, Ritu Raj Jallan, Shasya Shukla; Computer Aided Design of Electrical Machines; S.K. Kataria & Sons; 2014.

Online Resources

1. NPTEL (SWAYAM) https://nptel.ac.in/courses/108105112
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_ec09

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	3	3	2							1	2
CO2	3	3	3	3	3							1	2
CO3	3	1	2	1	2	3						2	1
CO4	2	2	2	2	1	2						1	2

Program	B. Tech CSE (CCML)				
Year	I	**Semester**	I/II		
Course Name	Basics of Artificial Intelligence				
Code	RCS5102/RCS5202				
Course Type	ESC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Knowledge of computer	3	0	0	3
Course Objectives	1. Study of historical perspectives of AI and its foundations. 2. Understanding the fundamental principles of AI. 3. Study of advanced AI techniques, like soft computing and nature-inspired computing. 4. Understanding different AI approaches like problem solving, inference, perception, knowledge representation and learning.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.				
CO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.				
CO3	Demonstrate advanced AI techniques, such as soft computing and nature-inspired computing				
CO4	Demonstrate awareness and a fundamental understanding of various applications of AI techniques.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction and Foundations of AI** Introduction to Artificial Intelligence (AI), definition, foundation and history of AI, types of AI such as Narrow AI, General AI and Super AI, foundations of AI including mathematics, logic and computer science, intelligent agents, types of agents, structure of intelligent agents such as simple reflex, model-based, goal-based and utility-based agents, environments of agents and performance measures, introduction to soft computing, fuzzy sets, membership functions and operations on fuzzy sets, introduction to nature inspired computing, genetic algorithms, particle swarm optimization and ant colony optimization, overview of modern AI tools and trends.	15 Hours	CO1

2	**Problem Solving and Search Techniques:** AI terminologies and basic concepts, problem formulation and state space representation, searching for solutions, uninformed search strategies including breadth first search, depth first search and uniform cost search, informed search strategies including heuristic functions, greedy best first search and A* algorithm, local search algorithms such as hill climbing and simulated annealing, global search and optimization techniques, adversarial search, game playing techniques, minimax algorithm and alpha beta pruning, introduction to game theory and multi agent systems, performance evaluation of search algorithms.	15 Hours	CO2
3	**Knowledge Representation, Reasoning and Applications:** Knowledge representation and reasoning, techniques of knowledge representation, propositional logic and logical connectives, theory of first order logic including syntax, semantics and quantifiers, inference mechanisms in first order logic including resolution and unification, forward and backward chaining, probabilistic reasoning, basics of probability theory, Bayesian networks, utility theory and decision making, introduction to machine learning and natural language processing, applications of artificial intelligence in healthcare, finance, cybersecurity, social media, transportation, robotics, agriculture, e commerce and education, ethical issues in AI including bias, fairness and privacy, future scope and impact of artificial intelligence on society.	15 Hours	CO3, CO4

Suggested Readings

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Edition, Pearson Education, Inc., 2010.
2. Nils J. Nilsson, *Artificial Intelligence: A New Synthesis*, 1st Edition, Harcourt Asia Pvt. Ltd., 2000.
3. Elaine Rich and Kevin Knight, *Artificial Intelligence*, 3rd Edition, Tata McGraw-Hill, 2003.
4. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 4th Edition, Pearson Education/PHI, 2002.
5. F. O. Karray and C. D. de Silva, *Soft Computing and Intelligent Systems Design: Theory, Tools, and Applications*, 1st Edition, Pearson Education, 2004.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc21_ge20/preview
2. https://www.youtube.com/@IITDelhiJuly

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	2	2	1									2	2
CO 2	2	2	1									2	2
CO 3	2	2	1									2	2
CO 4	2	2	1									2	2

Program	B. Tech CSE (CCML)					
Year	I	**Semester**	I/II			
Course Name	Electrical Engineering Lab					
Code	REE5151/REE5251					
Course Type	ESC		**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Physics and Electrical Concepts		0	0	2	1
Course Objectives	1. To understand electrical circuits through practical and simulation methods. 2. To apply network theorems using experiments. 3. To study AC/DC systems and measurements. 4. To analyze electrical machines and their applications.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Identify and study electrical equipment.					
CO2	Verify electrical circuit laws and theorems.					
CO3	Analyze AC circuits and power measurement.					
CO4	Study performance of electrical machines.					

S. No.	**List of Experiments**	**Mapped CO**
1	Study of Electrical Equipment used in Daily Life	CO1
2	Full Wave Rectifier using Diodes	CO1
3	Verification of KCL & KVL	CO2
4	Verification of Norton's Theorem	CO2
5	Verification of Thevenin's Theorem	CO2
6	Verification of Superposition Theorem	CO2
7	Measurement of 3-Phase Power (Two Wattmeter Method)	CO3
8	DC Shunt Motor Speed Control (Armature & Field)	CO4
9	Load Test on DC Machine & Efficiency Calculation	CO4
10	Transformer O.C. & S.C. Test and Performance Analysis	CO4

Suggested Reading:

1. https://bes-iitr.vlabs.ac.in/exp/electrical-equipments/theory.html
2. https://be-iitkgp.vlabs.ac.in/exp/full-wave-rectification/index.html
3. https://bes-iitr.vlabs.ac.in/exp/kirchhoff-law/
4. https://asnm-iitkgp.vlabs.ac.in/exp/verification-norton-theorem/theory.html
5. https://asnm-iitkgp.vlabs.ac.in/exp/verification-thevenin-theorem/theory.html
6. https://asnm-iitkgp.vlabs.ac.in/exp/verification-superposition-theorem/theory.html
7. https://elms-iitr.vlabs.ac.in/exp/three-phase-power/
8. https://ems-iitr.vlabs.ac.in/exp/dcmotor-field-resistance-control/theory.html
9. https://em-coep.vlabs.ac.in/exp/load-test-dc-motor/theory.html
10. https://ems-iitr.vlabs.ac.in/exp/circuit-parameters-oc-test/theory.html

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	3	3	2							1	
CO2	3	3	3	3	3							1	
CO3	3	2	2	2	2	3						2	
CO4	2	2	2	2	2	2						1	

Program	B. Tech CSE (CCML)				
Year	I	Semester	I/II		
Course Name	Engineering Graphics Lab				
Course Code	RME5152/RME5252				
Course Type	ESC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of mathematics and basic geometrical drawing skills	0	0	2	1
Course Objectives	1. To develop a fundamental understanding of engineering graphics principles, scales, projections, and graphical representation techniques used in engineering practice.				
	2. To enhance visualization and spatial reasoning skills for representing points, lines, planes, solids, and engineering objects in two-dimensional and three-dimensional forms.				
	3. To impart knowledge of engineering drawing standards, sectional views, development of surfaces and drafting conventions for effective communication of engineering designs.				
	4. To develop the ability to prepare and interpret engineering drawings using orthographic, isometric, and perspective projection techniques for engineering applications.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply engineering drawing principles to construct scales and prepare projections of points and lines.				
CO2	Prepare sectional views, surface developments and engineering drawings using drafting conventions.				
CO3	Visualize and represent planes, solids and engineering objects through orthographic and isometric projections.				
CO4	Develop and interpret complete engineering drawings of components and assemblies.				

S. No.	List of Experiments	Mapped CO
1	**Scales**: Representative factor, plain scales, diagonal scales, scales of chords.	CO1
2	**Projection**: Types of projection, orthographic projection, first and third angle projection.	CO1
3	**Projection of points:** The principle of orthographic projections of a point on HP and VP, Conventional representation, Projection of a point in all the quadrants.	CO1
4	**Projection of Lines:** Line inclined to one plane, inclined with both the plane, True Length and True Inclination, Traces of straight lines.	CO2
5	**Projection of planes and solids**: Projection of Planes like circle and polygons in different positions; Projection of polyhedrons like prisms, pyramids and solids of revolutions like cylinder, cones in different positions.	CO2

6	**Section of Solids:** Section of right solids by normal and inclined planes; Intersection of cylinders.	CO2
7	**Isometric Projections:** Isometric scale, Isometric axes, Isometric Projection from orthographic drawing.	CO3
8	**Perspective Projection:** Nomenclature of Perspective Projection, Method of drawing perspective views, Visual Ray Method, using Top and Front, Top and Side views.	CO3
9	**Computer Aided Drafting (CAD)-**I: Introduction, benefit, software's basic commands of drafting entities like line, circle, polygon, polyhedron, cylinders.	CO4
10	**Computer Aided Drafting (CAD)-**II: Transformations and editing commands like move, rotate, mirror, array; solution of projection problems on CAD.	CO4

Suggested Reading:

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Ltd., Anand, Gujarat, 2014.
2. K. L. Narayana and P. Kannaiah, Engineering Drawing, 3rd Ed., Scitech Publications (India) Pvt. Ltd., Chennai, 2012.
3. D. A. Jolhe, Engineering Drawing with an Introduction to AutoCAD, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2016.

Online Resources:

2. https://www.vlab.co.in
3. https://nptel.ac.in
4. https://www.autodesk.com/education/home
5. https://www.autodesk.com/learn
6. https://spoken-tutorial.org

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	1	1	-	-	-	-	-	-	1	1
CO2	3	3	2	1	1	-	-	-	-	-	-	1	1
CO3	2	3	3	1	1	-	-	-	-	-	-	1	1
CO4	3	3	3	2	1	-	-	-	-	-	-	1	1

Program	B. Tech. CSE (CCML)					
Year	I	**Semester**	II			
Course Name	Introduction to Java Programming					
Code	RCCML5202					
Course Type	PCC		**L**	**T**	**P**	**Credit**
Pre-Requisite	Basics of any Programming Language.		3	0	0	3
Course Objectives	1. To introduce the fundamentals of Java programming and problem-solving techniques. 2. To develop an understanding of object-oriented programming concepts and their implementation using Java. 3. To build robust applications using arrays, strings and exception handling. 4. To develop Java applications involving collections and file processing.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Apply Java programming fundamentals, control structures and methods to develop solutions for computational problems.					
CO2	Design and implement object-oriented software solutions using classes, objects, inheritance, polymorphism, abstraction and interfaces.					
CO3	Develop reliable Java applications utilizing arrays, strings and exception handling concepts.					
CO4	Build integrated Java applications using collections and file handling.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**JAVA fundamentals and Programming Logic:** Introduction to programming and Java, features of Java, Java architecture, JDK, JRE and JVM, Java program structure, compilation and execution process, identifiers, variables, constants, data types, operators and expressions, type conversion and casting, input and output operations, control statements including conditional statements (if, if-else, nested if, switch) and iterative statements (for, while, do-while), jump statements (break, continue), methods, parameter passing, scope and lifetime of variables, and basic program development and debugging techniques.	15 Hours	CO1
2	**Object Oriented Programming in JAVA:** Introduction to object-oriented programming concepts, classes and objects, constructors, methods, access modifiers, encapsulation, inheritance (single, multilevel and hierarchical inheritance), method overloading, method overriding, polymorphism, abstraction, abstract classes, interfaces, packages, static members, this and super keywords, and design and implementation of object-oriented applications using Java.	15 Hours	CO2

3	**Arrays, Strings and Exception Handling:** One-dimensional and two-dimensional arrays, array operations and applications, string handling using String, String Buffer and String Builder classes, commonly used string methods, command-line arguments, exception handling mechanisms, try-catch-finally blocks, throw and throws keywords, user-defined exceptions, and exception propagation. **Collections, File Handling and Database Connectivity:** Introduction to Java Collection Framework, Collection hierarchy, List, Set and Map interfaces, Array List, Linked List, Hash Set, file handling using File, File Reader, File Writer, Buffered Reader, and Buffered Writer classes, serialization basics, introduction to JDBC architecture, JDBC drivers.	15 Hours	CO3, CO4

Suggested Readings:

1. Patrick Naughton and Herbertz Schildt, "Java-2: The Complete Reference", TMH, 1999,5th Edition.
2. Bill Vanners, "Inside Java Virtual Machine", TMH, 2nd Edition.
3. Rick Dranell, "HTML 4 Unleashed", Techmedia Publication, 2000, 2nd Edition
4. Paul Dietel and Harvey Deitel, "Java How to Program", PHI, 2010, 8th Edition.

Online Resources:

1. https://www.youtube.com/@IITKharagpurJuly-is9ie
2. https://docs.oracle.com/en/java/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2		2					1			
CO2	3	3	3		2				1	1	1	2	2
CO3	3	3	3	1	2			1	1	1			2
CO4	3	3	3	2	3			1	1	2	1	2	

Program	B. Tech CSE (CCML)				
Year	I	**Semester**	II		
Course Name	Java Programming Lab				
Code	RCCML5252				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basics of Java Programming	0	0	2	1
Course Objectives	1. To introduce the fundamentals of Java programming and problem-solving techniques. 2. To develop an understanding of object-oriented programming concepts and their implementation using Java. 3. To build robust applications using arrays, strings, exception handling and multithreading. 4. To develop Java applications involving collections, file processing and database connectivity.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply Java programming fundamentals, control structures and methods to develop solutions for computational problems.				
CO2	Design and implement object-oriented software solutions using classes, objects, inheritance, polymorphism, abstraction and interfaces.				
CO3	Develop reliable Java applications using arrays, strings, exception handling, and multithreading.				
CO4	Build integrated Java applications using collections and file handling.				

S. No.	List of Experiments	Mapped CO
1	Implement programs using one-dimensional and two-dimensional arrays for matrix addition, multiplication, and searching/sorting operations.	CO1
2	Write a Java program to demonstrate the creation and use of classes and objects by implementing a Student2 class with methods to initialize and display student details. Create two objects s1 and s2 in a separate test class and invoke the methods to manage and display the information of different students.	CO1
3	Develop an Employee Management application demonstrating inheritance (single, multilevel, and hierarchical inheritance).	CO2
4	Implement a Shape hierarchy using method overloading, method overriding, and runtime polymorphism.	CO2
5	Write a program using a parameterized constructor with two parameters, id and name. While creating the objects obj1 and obj2, two arguments were passed so that this constructor gets invoked after creation of obj1 and obj2.	CO2
6	Design a Banking System using abstract classes and interfaces to demonstrate abstraction and multiple inheritance through interfaces.	CO2
7	Develop applications using String, String Buffer, and String Builder classes for text processing and manipulation.	CO3

8	Write a program in Java, if the number is less than 10 or greater than 50, it generates an out-of-range exception. Otherwise, it displays the square of a number.	CO3
9	Create a custom exception handling application (e.g., Invalid Age, Insufficient Balance, Invalid Marks) using try-catch-finally, throw, and throws.	CO3
10	Create a file-based Employee Record System using file handling classes to perform read, write, append, and search operations.	CO4

Suggested Readings:

1. Paul Deitel and Harvey Deitel, "Java How to Program", Pearson Education, 2018,11th Edition.
2. E. Balagurusamy, "Programming with Java", McGraw-Hill Education, 2019, 6th Edition.

Online Resources:

1. https://java-iitd.vlabs.ac.in/
2. https://docs.oracle.com/en/java/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3	3	2	1	2					1		2	
CO 2	3	3	3	1	2				1	1	1	2	
CO 3	3	3	2	2	2			1	1	1		2	2
CO 4	3	3	3	2	3			1	1	2	1	2	

Program	B.Tech CSE (CCML)				
Year	II	**Semester**	III		
Course Name	Startup and Innovation				
Code	RMC5311				
Course Type	MC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Artificial Intelligence and innovation concepts.	2	0	0	2
Course Objectives	1. Understand entrepreneurship concepts in the context of Artificial Intelligence. 2. Develop skills to identify AI-based business opportunities and innovative solutions. 3. Learn startup development, business models, and funding mechanisms for AI ventures. 4. Analyze ethical, legal, and societal aspects of AI innovation and commercialization.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain the fundamentals of AI entrepreneurship, innovation ecosystems, emerging AI technologies and the startup lifecycle.				
CO2	Analyze market opportunities and develop AI-based products using customer discovery, design thinking, lean startup methodology, and business models.				
CO3	Apply AI startup management principles, including team building, project management, commercialization strategies, intellectual property rights, and regulatory compliance.				
CO4	Evaluate funding options, ethical considerations, sustainability practices, risk management strategies, and prepare effective business pitches for AI ventures.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Foundations of AI Entrepreneurship:** Entrepreneurship concepts, innovation ecosystem, AI industry landscape, emerging AI technologies, startup lifecycle, entrepreneurial mindset, opportunity recognition, Enterprise Design Thinking principles, human-centered innovation, empathy mapping, user research, problem framing, stakeholder collaboration. **AI Business Opportunities and Product Development:** Market analysis, customer discovery, problem identification, AI product development lifecycle, value proposition design, lean startup methodology, business	15 Hours	CO1, CO2

	model canvas, AI-enabled products and services.		
2	**AI Startup Management and Commercialization:** Startup formation, team building, project management, AI business strategies, commercialization of AI solutions, intellectual property rights, patents, licensing, AI regulations and compliance. **Funding, Ethics and Innovation:** Venture capital, angel investors, crowdfunding, financial planning, AI ethics, responsible AI, sustainability, risk management, global AI innovation trends, startup case studies and business pitch preparation.	15 Hours	CO3, CO4

Suggested Readings

1. Burns, Paul. Corporate entrepreneurship and innovation. Bloomsbury Publishing, 2020.
2. Brueggemann, Ralph F., and Charles H. Matthews. Innovation and entrepreneurship: A competency framework. Routledge, 2024.
3. Bessant, John R., and Joe Tidd. Entrepreneurship. John Wiley & Sons, 2018.

Online Resources

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_mg63
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_mg95
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_mg80

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	1	-	2	-	-	-	-	1	2	2	2
CO2	2	3	2	1	3	-	-	-	1	2	2	3	2
CO3	2	2	3	1	2	2	-	-	2	2	3	2	3
CO4	1	2	2	-	1	3	3	3	1	2	2	1	2

Program	B. Tech. (CCML)				
Year	II	**Semester**	III		
Course Name	C Programming				
Code	RCS5301				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of computer systems and operating systems & Fundamental mathematical and logical reasoning skills.	3	1	0	4
Course Objectives	1. Understand the fundamentals of C programming, data types, operators, and control structures to develop simple programs. 2. Develop modular programs using functions, arrays, strings, and pointers for solving computational problems. 3. Apply structures, unions, file handling, and dynamic memory concepts in real-world programming applications. 4. Design, develop, test, and debug C programs using modern programming practices and problem-solving techniques.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain C programming fundamentals and implement programs using variables, operators, and control statements.				
CO2	Develop programs using functions, arrays, strings, and pointers to solve engineering problems.				
CO3	Implement structures, unions, file operations, and dynamic memory allocation in application-oriented programs.				
CO4	Analyze, design, debug, and evaluate C programs using appropriate programming tools and coding standards.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to C Programming:** History of C, Structure of C Program, Tokens, Data Types, Variables, Constants, Operators, Input/output Functions, Decision Making Statements, Loops	15 Hours	CO1
2	**Functions, Arrays and Strings:** User Defined Functions, Recursion, Scope of Variables, One-Dimensional and Two-Dimensional Arrays, String Handling Functions	15 Hours	CO2
3	**Pointers and User Defined Data Types:** Pointers, Pointer Arithmetic, Arrays and Pointers, Structures, Unions, Enumerations, Typedef	15 Hours	CO3
4	**File Handling and Dynamic Memory Allocation:** File Operations, Command Line Arguments, Dynamic Memory	15	CO4

	Allocation (malloc, calloc, realloc, free), Program Testing and Debugging	Hours	

Suggested Readings:

1. Van der Linden, Peter. Expert C programming: deep C secrets. Prentice Hall Professional, 1994.
2. Banahan, Mike, Declan Brady, and Mark Doran. The C book. Addison-Wesley Publishing Company, 1988.
3. Oualline, Steve. Practical C programming. " O'Reilly Media, Inc.", 1997.
4. Kernighan, Brian W., and Dennis M. Ritchie. The C programming language. Pearson Educación, 1988.

Online Resources:

1. NPTEL – Programming in C
   https://nptel.ac.in
2. GeeksforGeeks – C Programming
   https://www.geeksforgeeks.org/c-programming-language/
3. TutorialsPoint – C Programming Tutorial
   https://www.tutorialspoint.com/cprogramming/
4. GNU C Documentation
   https://gcc.gnu.org/onlinedocs/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	-	-	1	-	-	-	-	-	1	2	-
CO2	3	3	2	1	2	-	-	-	-	-	1	2	2
CO3	2	2	3	2	3	-	-	-	-	-	1	2	3
CO4	2	3	3	2	3	-	1	1	1	-	2	2	3

Program	B. Tech (CSE-CCML)				
Year	II	Semester	III		
Course Name	Database Management Systems				
Course Code	RAI5302				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic understanding of file systems and data organization	3	1	0	4
Course Objectives	1. To introduce the basics of Database Management System and architecture.				
	2. Understanding the fundamental relational system, data model and SQL.				
	3. Illustrate the concepts of normalization and transaction.				
	4. Understand the concepts of NoSQL using MongoDB and Cassandra for Big Data				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the architecture of database and management.				
CO2	Constructing conceptual data models and SQL queries.				
CO3	Understand the functional dependencies, normalization and transaction processing techniques.				
CO4	Understand and Compare the work on NoSQL environment and MongoDB and Cassandra.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Database System Concepts, Architecture, and Cloud Infrastructure:** Introduction to Database System with example, Characteristics of the Database Approach, Users of Database System, Advantages and disadvantages of Using a DBMS, Data Models, Schemas, and Instances, DBMS Architecture and Data Independence, Database Languages and Interfaces. Introduction to Cloud Database Architectures, Database-as-a-Service (DBaaS) models (e.g., Amazon RDS, Google Cloud SQL), Server less Databases, and multi-tenant database architectures.	15 Hours	CO1

2	**Data Modeling, and Structured Query Language:** Data Modeling Using the Entity-Relationship Model, mapping constraints, keys, Entity Types, Sets, Attributes, Relationships, Enhanced Entity Relationship Modeling, Subclasses, Super classes, Inheritance, Specialization and Generalization, Structured Query Language (SQL) Basics, Data Definition, Constraints, Schema Changes, Insert/Delete/Update Statements, Queries and Sub queries, Aggregate Functions, Joins.	15 Hours	CO2
3	**Database Design and Transaction with Concurrency Control:** Functional Dependencies and Normalization for Relational Databases, Normal Forms Based on Primary Keys (1NF, 2NF, 3NF), Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF), and Fifth Normal Form (5NF), Transaction Processing Concepts, Transaction states and State Diagram, Properties of Transactions (ACID), Schedules and Recoverability, Serializability of Schedules, Concurrency Control and Techniques, Database Recovery.	15 Hours	CO3
4	**NoSQL Big Data Management, MongoDB and Cassandra:** Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases, Cassandra Databases.	15 Hours	CO4

Suggested Readings

1. Silberschatz, Abraham, Henry F. Korth, and S. Sudarshan. Database System Concepts. 7th ed., McGraw-Hill Education, 2020
2. Elmasri, Ramez, and Shamkant B. Navathe. Fundamentals of Database Systems. 8th ed., Pearson, 2022.
3. Ramakrishnan, Raghu, and Johannes Gehrke. *Database Management Systems*. 3rd ed., McGraw-Hill, 2002.
4. Erl, Thomas, and Eric Barceló Monroy. *Cloud Computing: Concepts, Technology, Security & Architecture*. 2nd ed., Pearson Education, 2023. .
5. G. Harrison, *Next Generation Databases: NoSQL, NewSQL, and Big Data*, 1st ed. Berkeley, CA, USA: Apress, 2015.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc22_cs51/preview
2. https://www.udemy.com/topic/database-management

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	1	1							1	1	1
CO2	3	3	3	2	2						2	2	2
CO3	3	3	3	2	2						2	2	2
CO4	3	3	3	2	3						2	2	2

Program	B. Tech. CSE(CCML)				
Year	II	Semester	III		
Course Name	Fundamentals of Data Science.				
Course Code	RCCML5301				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamental understanding of mathematics, statistics, and programming concepts.	2	1	0	3
Course Objectives	1. To provide an overview of Data Science, Business Analytics and Predictive Analytics, and their role in data-driven decision making. 2. To introduce the tools and techniques required for data preparation, exploratory data analysis and predictive analytics using IBM SPSS Modeler and IBM Watson Studio. 3. To review, explore and transform data for identifying patterns, trends, missing values and other data quality issues for effective predictive modeling. 4. To enable students to develop analytical skills for building, evaluating and interpreting predictive models to solve real-world business and societal problems				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain the fundamentals of Data Science, Business Analytics and Predictive Analytics.				
CO2	Apply data preparation, exploratory analysis and visualization techniques using IBM SPSS Modeler.				
CO3	Develop and evaluate basic predictive models using IBM Watson Studio and Auto AI tools.				
CO4	Analyze real-world datasets, interpret predictive results and demonstrate ethical use of AI-driven analytics solutions.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Data Science and Analytics** Introduction to Data Science, Data Science Lifecycle, Types of Data, Data-driven Decision Making, Business Analytics and Predictive Analytics, Predictive Analytics: Transforming Data into Future Insights, Analytics Trends: Past, Present and Future,	15 Hours	CO1

	Towards a Predictive Enterprise, Real-world Applications of Data Science in Healthcare, Finance, Retail and Education. **IBM SPSS Modeler & Data Mining** What are Data Mining applications? Strategy for data mining: CRISP-DM, Identify nodes & streams, The framework of a Data – mining project, Brief the unit of analysis, Explain the type of dialog box.		
2	**Data Preparation and Exploratory Analytics** Data Collection and Data Quality Assessment, Handling Missing Values and Outliers, Data Cleaning and Transformation, Exploratory Data Analysis (EDA), Data Visualization Techniques, Descriptive Statistics, Correlation Analysis, Feature Engineering Concepts, Identifying the Modeling Objective and Understanding Business Problems. **Advanced Data Preparation with IBM SPSS Modeler** Functions to Enrich Data, Methods to Transform Data, Cross-record Functions, Sampling Techniques, Partitioning and Sampling Data, Integrating Data Sources, CLEM Expressions, Relationship between Fields, Improving Efficiency and Data Preparation for Predictive Modeling.	15 Hours	CO2
3	**Predictive Analytics Fundamentals** Introduction to Predictive Modeling, Predictive Analytics Workflow, Training and Testing Datasets, Regression Concepts, Classification Concepts, Clustering Overview, Feature Selection Techniques, Model Evaluation and Validation, Confusion Matrix, Accuracy, Precision, Recall and F1-Score, Introduction to Explainable AI and Model Interpretation. **Predictive Analytics with IBM Watson Studio** IBM Watson Studio, Watson Studio Components, Data Preparation, Watson Machine Learning, Data Refinery, Watson Studio Neural Network Modeler, IBM Watson Studio Jobs, Auto AI, Building and Evaluating Predictive Models using Watson Studio **Applied Predictive Analytics and Emerging Trends**	15 Hours	CO3, CO4

	Predictive Analytics Applications in Business and Industry, Customer Churn Prediction, Sales Forecasting, Risk Analysis and Decision Support Systems, Recommendation Systems Overview, Introduction to Machine Learning for Predictive Analytics, AI-assisted Analytics Tools, Model Deployment Concepts, Future Trends in Data Science		

Suggested Readings

1. IBM, *IBM Courseware*, IBM Corp., 2015.
2. E. Siegel, *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die*, Hoboken, NJ, USA: Wiley, 2013, 1st Edition.
3. I. H. Witten, E. Frank, M. A. Hall, and C. J. Pal, *Data Mining: Practical Machine Learning Tools and Techniques*, Burlington, MA, USA: Morgan Kaufmann, 2016,4th Edition.
4. S. C. Albright and W. L. Winston, *Business Analytics: Data Analysis and Decision Making*, Boston, MA, USA: Cengage Learning, 2023,7th Edition.

Online Resources

1. Predictive Analytics World
   https://www.predictiveanalyticsworld.com

2. IBM Skills Build – Data Science and AI Learning Resources
   https://skillsbuild.org

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	2	1	1						1	1	2
CO2	2	1	2	1	1						1	1	2
CO3	1	2	1	2	1						2	1	2
CO4	1	2	2	2	2						1	2	1

Program	B. Tech CSE (CCML)				
Year	II	**Semester**	III		
Course Name	C Programming Lab				
Code	RCS5351				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Knowledge of C	0	0	2	1
Course Objectives	1. Formulate problems and implement algorithms using the C programming language. 2. Learn memory allocation techniques using pointers. 3. Learn memory allocation techniques using pointers 4. Use a structured programming approach for solving computing problems in the real world.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the concept of basics of C, data types and variables.				
CO2	Understand the concept of operators, precedence of operators, conditional statements and looping statements.				
CO3	Explore the concept of strings, functions, recursive functions and differences between call by value and call by reference.				
CO4	Understand the concept of file handling functions, searching and sorting methods and real time applications of C.				

S. No.	List of Experiments	Mapped CO
1	Write a program that accepts the marks of 5 subjects and finds the sum and percentage marks obtained by the student.	CO1, CO2
2	Write a program that swaps values of two variables using a third variable.	CO1, CO2
3	Write a program to find the greatest of three numbers.	CO1, CO2
4	Write a program that finds whether a given number is even or odd.	CO1, CO2
5	Write a program that takes two operands and one operator from the user and perform the operation and prints the result by using Switch statement.	CO2, CO3
6	Write a program to find the factorial of a given number.	CO3, CO4
7	Write a program that simply takes elements of the array from the user and finds the sum of these elements.	CO2, CO3, CO4
8	Write a program to search an element in a array using Linear Search.	CO2, CO3, CO4

9	Write a program to add and multiply two matrices of order nxn.	CO2, CO3, CO4
10	Write a program to implement strlen (), strcat (), strcpy () using the concept of Functions.	CO2, CO3, CO4

Suggested Readings

1. Byron Gottfried, "Programming with C", Schaum's Outlines Series, McGraw Hill Education, 3rd Edition, 2017.
2. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education, 6th Edition, 2012.
3. Yashavant Kanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003.
4. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014

Online Resources

1. https://ps-iiith.vlabs.ac.in/
2. https://www.vlab.co.in/ba-nptel-labs-computer-science-and-engineering

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1				2							1	1
CO2	1	2	2									2	2
CO3	2	2	2	2	2						1	2	2
CO4	1	2	2	2	2						2	2	2

Program	B. Tech CSE (CCML)					
Year	II	Semester	III			
Course Name	Database Management Systems Lab					
Course Code	RAI5352					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic Understanding of File Systems, Data Organization.	0	0	2	1	
Course Objectives	1. Students are able to design, develop databases.					
	2. Students are able to query a database.					
	3. Students are able to take backup and rollback databases.					
	4. Students are able to understand the CRUD operation on MongoDB.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Understand the database language command and also create simple database.					
CO2	Analyze the database using queries to retrieve records.					
CO3	Analyze the retrieve the information using different clauses for processing databases.					
CO4	Understand the different operations on MongoDB and retrieve the record.					

S. No.	**List of Experiments**	**Mapped CO**
1	Write SQL queries for Data Definition and Data Manipulation Language.	CO1
2	Write SQL queries using logical operations (=, <,>, etc).	CO1
3	Write SQL queries using SQL operators.	CO2
4	Write SQL query using character, number, date and group functions.	CO1
5	Write SQL queries for extracting data from more than one table.	CO4
6	Write SQL queries for sub queries, nested queries.	CO2
7	Write SQL queries for retrieving information from the database	CO3

	using the Group by and Having clause.	
8	Write SQL queries for ROLL BACK, COMMIT.	CO4
9	Create VIEWS and understand its concept.	CO3
10	Write CRUD (Create, Read, Update, and Delete) operations on the databases: MongoDB.	CO4

Online Resources:

1. http://vlabs.iitkgp.ernet.in/se/4/theory
2. https://vlab.iitr.ac.in/assets/explorelabs/Database%20management%20system%20lab/labs/index.html

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	1		2							1	1
CO2	3	2	2	1	1							2	1
CO3	2	3	1	1	2							2	1
CO4	3	3		1	2							3	1

Program	B. Tech. CSE (CCML)				
Year	II	Semester	III		
Course Name	Data Science Lab				
Course Code	RCCML5351				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamental understanding of Mathematics, Statistics, Python Programming, and Data Science concepts.	0	0	2	1
Course Objectives	1. To provide hands-on experience in data acquisition, preprocessing, and analysis using Python-based data science tools and libraries. 2. To develop practical skills in applying statistical and probabilistic techniques for data exploration and decision-making. 3. To enable students to perform descriptive, correlation, and regression analysis on real-world datasets. 4. To enhance problem-solving abilities through the implementation of data-driven analytical solutions.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply Python libraries and tools for data manipulation, visualization, and analysis.				
CO2	Perform statistical and probability-based analysis to extract meaningful insights from datasets.				
CO3	Conduct descriptive analytics and exploratory data analysis on benchmark and real-world datasets.				
CO4	Apply correlation and regression techniques to analyze relationships among variables and support data-driven decision-making.				

S. No.	List of Experiments	Mapped CO
1	Exploration of IBM SPSS Modeler Environment and Data Mining Workflow.	CO1
2	Development of a Data Mining Project for Customer Churn Prediction in the Telecommunications Domain.	CO1
3	Analysis and Understanding of Telecommunications Data.	CO1
4	Identification and Establishment of the Unit of Analysis for	CO2

	Telecommunications Data.	
5	Integration of Telecommunications Data for Predictive Analytics.	CO2
6	Customer Churn Prediction and Customer Segmentation using Clustering Techniques.	CO2
7	Data Cleansing and Enrichment of Telecommunications Data using Built-in Functions and Transformations.	CO3
8	Enhancement of Analytical Efficiency using Telecommunications Data.	CO3
9	Data Analysis and Visualization using IBM Watson Studio.	CO3
10	Development of a Machine Learning Model using IBM Watson Studio and Auto AI.	CO4
11	Comparative Evaluation of Predictive Models using Performance Assessment Techniques.	CO4
12	Design and Implementation of an End-to-End Predictive Analytics Solution using Real-World Datasets.	CO4

Online Resources

1. IBM Skills Build – Data Science and Analytics Learning Resources
   https://skillsbuild.org
2. Data Analytics Virtual Lab, IIITM-K
   https://www.iiitmk.ac.in/DAVirtalLab/#work
3. IBM Watson Studio Documentation and Tutorials
   https://www.ibm.com/docs/en/watson-studio
4. Kaggle Learn – Data Science and Machine Learning Labs
   https://www.kaggle.com/learn

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	3	1	2								3	3
CO2	2	1		2							1	3	2
CO3	1	2	3	1							1	2	2
CO4	1		3	2								3	3

Program	B.Tech CSE (CCML)				
Year	II	**Semester**	III		
Course Name	YOGA Activities				
Code	RMC5351				
Course Type	MC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamental Concepts of Yoga	0	0	2	1
Course Objectives	1. To enable the student to have good health. 2. To practice mental hygiene. 3. To possess emotional stability. 4. To integrate moral values. And To attain higher level of consciousness.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	To Understand the Concept of Yoga and its Historical Development.				
CO2	To Analyse the relevance of Yoga in modern age and its scope.				
CO3	To Apply, the Concept of Yoga in different texts.				
CO4	To evaluate the difference between Yogic and non-yogic system of exercises.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	General Introduction of Yoga: Yoga it's Origin, Meaning, Definition & Objectives, Historical Development of Yoga, Relevance of Yoga in modern age and scope, Misconceptions about Yoga and their solutions, Difference between physical exercise and yoga Sans system of exercises. Yoga Sans for male and female	7 Hours	CO1, CO2
2	Purification Practice Dhauti/yogic Eneama/Neti/Eye protection Yoga Practices. 1. AsanasYoga Stretching, Suryanamaskar(Warming-up), Standing Asana, SittingAsana, Prone position Asana, Supine position Asana, Meditative Asana, Relaxation Asana 2. Pranayam- Why pranyam? How to practise of pranyam? • AnulomaViloma/Surya Bhedana Pranayama • Sheetlipranyam/sheetkaripranyam/Brhamaripranyam/ kapalbhati • Ujjayi Pranayama • Kumbhaka Pranayama • Sampoorna Yoga Shwasana (Full Yogic Breathing • Balance Diet	8 Hours	CO3, CO4

	• Inner silence 3. Meditation and Mudras		

Suggested Reading

1. Prof. Ramharsh Singh – Yoga Avam Yoga Chikitsa, Chaukhambha Sanskrit Pratishthan, Delhi-07 2.
2. K.S. Joshi - Yoga in Daily Life, Orient Paper Back Publication, New Delhi, 1985
3. Vijnananand Saraswati - Yoga Vigyan, Yoga Niketan Trust, Rishikesh, 1998.
4. Rajkumari Pandey-Bhartiya Yoga Paramparake VividhAyam, Radha Publication, New Delhi, 2008

Online Resources

1. Yoga and Positive Psychology for Managing Career and Life - Course (nptel.ac.in)https://nptel.ac.in/courses/106105218
2. NPTE: Management - NOC: Yoga and Positive Psychology for Managing Career and Life.

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1							2	2					2
CO2							2	2					2
CO3							1	2					2
CO4							2	2					2

Program	B. Tech. CSE(CCML)				
Year	II	**Semester**	IV		
Course Name	Big Data Analytics and Architecture				
Code	RAIBC5401				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Java, HADOOP frameworks, Clustering techniques, large data sets, PIG and HIVE	3	1	0	4
Course Objectives	1. Optimize business decisions and create a competitive advantage with Big Data analytics 2. Understand several key big data technologies used for storage, analysis and manipulation of data. 3. Recognise the key concepts of the Hadoop framework, MapReduce. 4. To learn Basic methodologies of PIG and HIVE.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Demonstrate an understanding of Big Data, its importance, sources, and the four key characteristics — volume, variety, velocity, and veracity.				
CO2	Analyze frameworks such as Hadoop and NoSQL to efficiently store, manage, and process Big Data for analytics.				
CO3	Design and implement algorithms to solve data-intensive problems using the MapReduce paradigm.				
CO4	Demonstrate and evaluate the use of Pig and Hive frameworks to process Big Data and generate analytics.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**ESSENTIALS OF BIG DATA AND ANALYTICS:** Data, Characteristics of data and Types of digital data, Sources of data, Working with unstructured data, Evolution and Definition of big data, Characteristics and Need of big data, Challenges of big data; Overview of business intelligence, Data science and Analytics, Meaning and Characteristics of big data analytics, Need of big data analytics, Classification of analytics, Challenges to big data analytics, Importance of big data analytics, Basic terminologies in big data environment.	15 Hours	CO1
2	**HADOOP :** Introducing Hadoop, Need of Hadoop, limitations of RDBMS, RDBMS versus Hadoop, Distributed computing challenges, History of Hadoop, Hadoop overview, use case of Hadoop, Hadoop distributors, HDFS (Hadoop Distributed File System), Processing data with Hadoop, managing resources and applications with Hadoop YARN (Yet another Resource Negotiator), Interacting with Hadoop Ecosystem.	15 Hours	CO2

3	**MAPREDUCE PROGRAMMING:** Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Real-time applications using MapReduce, Data serialization and working with common serialization formats, Big data serialization formats.	15 Hours	CO3,
4	**INTRODUCTION TO PIG and HIVE:** Introducing Pig: Pig architecture, Benefits, Installing Pig, Properties of Pig, Running Pig, Getting started with Pig Latin, Working with operators in Pig, Working with functions in Pig. Introducing Hive: Getting started with Hive, Hive Services, Data types in Hive, Built-in functions in Hive, Hive DDL.	15 Hours	CO4

Suggested Readings

1. S. Acharya and S. Chellappan, *Big Data and Analytics*, Hoboken, NJ, USA: Wiley Publications, 2014,2nd Edition.
2. DT Editorial Services, *Big Data*, New Delhi, India: Dreamtech Press, 2015,2nd Edition.
3. T. White, *Hadoop: The Definitive Guide*, Sebastopol, CA, USA: O'Reilly Media, 2012,3rd Edition.
4. Dreamtech Publications, *Black Book: Big Data*, New Delhi, India: Dreamtech Press, 2017,1st Edition.

Online Resources

1. https://nptel.ac.in/courses/106104189

Course Articulation Matrix

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1		1							1	3	2
CO2	3	2		2							1	2	3
CO3	3	1	3	2	2						1	3	3
CO4	3		3	2	1							3	2

Program	B. Tech. CSE(CCML)				
Year	II	**Semester**	IV		
Course Name	Cloud Computing				
Code	RCCML5402				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Cloud Computing and Programming fundamentals.	3	0	0	3
Course Objectives	1. To understand the fundamentals of cloud computing, cloud service models, deployment models, and AWS global infrastructure.				
	2. To learn AWS cloud services and deploy applications using EC2, Elastic Beanstalk, S3, Lambda, and monitoring tools.				
	3. To understand DevOps practices, version control systems, GitHub collaboration, and CI/CD pipeline automation.				
	4. To develop RESTful APIs using Node.js and implement containerization and orchestration using Docker and Kubernetes.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand cloud computing concepts, service models, and deployment models.				
CO2	Learn to develop and deploy cloud-based applications using AWS.				
CO3	Understand DevOps practices, GitHub, and CI/CD pipelines.				
CO4	Gain knowledge of REST APIs, Docker, Kubernetes, and cloud-native applications.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Cloud Computing:** Introduction to Cloud Computing, evolution of cloud computing, characteristics, advantages, and challenges of cloud computing, cloud service models including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), cloud deployment models such as Public Cloud, Private Cloud, and Hybrid Cloud,	15 Hours	CO1

	introduction to AWS Cloud and its global infrastructure.		
2	**AWS Cloud Services:** This module focuses on AWS cloud services and application deployment. Students will learn about Amazon EC2, AWS Elastic Beanstalk, Amazon S3, AWS Lambda, and basic database services. The module covers deployment of Node.js applications on AWS, cloud resource management, and monitoring applications using AWS tools.	15 Hours	CO2
3	**DevOps and CI/CD:** Introduction to DevOps concepts and software deployment practices, Git and GitHub fundamentals, repository management, version control systems, branching and collaboration strategies, Continuous Integration (CI), Continuous Deployment (CD), CI/CD pipeline automation, Deployment automation using DevOps services. **REST APIs and Containerization:** This module covers the development of RESTful web services using Node.js and Express.js. Students will learn HTTP methods, JSON data exchange, API design principles, and CRUD operations. The module also introduces Docker containers, Docker Hub, Kubernetes architecture, Pods, Deployments, and Services for containerized application management.	15 Hours	CO3, CO4

Suggested Readings

1. T. Erl, *Cloud Computing: Concepts, Technology & Architecture*, Boston, MA, USA: Pearson Education, 2013, 1st Edition.
2. B. Piper, *AWS Certified Cloud Practitioner Study Guide*, Hoboken, NJ, USA: Wiley, 2019,1st Edition.
3. M. Krief, *Learning DevOps*, Birmingham, UK: Packt Publishing, 2019,1st Edition.
4. N. Poulton, *Docker Deep Dive*, Birmingham, UK: Packt Publishing, 2020,5th Edition.

Online Resources

1. https://aws.amazon.com/training/
2. https://docs.aws.amazon.com/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	2	2	2	1	2				1	2		2	2
CO 2	3	1	3	2	2	1	2		1	2	3	2	2
CO 3	2	2	2	1	2			1	3	2	2	2	3
CO 4	3	1	3	2	2	1	1	1	2	2	2	2	2

Program	B. Tech. CSE(CCML)				
Year	II	**Semester**	IV		
Course Name	Operating Systems				
Code	RCS5404				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Knowledge of Computer System.	3	1	0	4
Course Objectives	1. Understand the structure and functions of OS and analyse Processes, Threads and Scheduling algorithms. 2. Analyse O.S concepts that include architecture mutual exclusion algorithms, deadlock detection algorithms and agreement. 3. Understand the principles of concurrency and Deadlocks. 4. Analyse various memory management schemes. Study I/O management and File systems.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understanding of the concepts, structure and design of OS and Learning about Processes, Threads and Scheduling algorithms.				
CO2	Understand the principles of concurrency and Deadlock.				
CO3	Evaluate various memory management schemes.				
CO4	Analyse and Implement a prototype file system.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Operating System and Process Concept** Operating system and functions, Types of Operating System, Classification of Operating systems, Operating System Structure, Operating System Services, System call and System program, Process concept, Process state, Process control block, Context switching, Operation on process, Threads and their management, Benefits of multithreading, Types of threads, Threading issues, CPU-scheduling, Scheduling criteria, Scheduling Algorithms, Concurrent Processes, Inter Process Communication models and Schemes.	15 Hours	CO1
2	**Process Synchronization and Deadlock** Process synchronization, Producer/Consumer Problem, Critical Section Problem, Peterson's solution, Synchronization of hardware, Semaphore, Classical-problem of synchronization, Deadlock, Deadlock characterization, Deadlock Prevention, Deadlock Avoidance, Resource allocation graph algorithm, Banker's algorithm, Deadlock detection, Recovery from deadlock.	15 Hours	CO2
3	**Memory Management** Memory Management, Multiprogramming with fixed partitions, Multiprogramming with variable partitions, Paging, Segmentation, Paged segmentation, Virtual memory concepts, Demand paging, Performance of demand paging, Page replacement algorithms, Thrashing.	15 Hours	CO3

4	**I/O Management and File System** File System Structure, File System Implementation, Directory Implementation and Allocation Methods, Free space Management, Kernel I/O Subsystems, Disk Structure, Disk Scheduling, Disk Management, Swap-Space Management.	15 Hours	CO4

Suggested Readings

1. A. Silberschatz, P. B. Galvin, and G. Gagne, *Operating System Concepts*, Hoboken, NJ, USA: Wiley, 2018,9th Edition.
2. S. Halder and A. A. Aravind, *Operating Systems*, New Delhi, India: Pearson Education, 200,1st Edition.
3. H. M. Deitel, *An Introduction to Operating Systems*, Boston, MA, USA: Pearson Education, 1990, 1st Edition.
4. D. M. Dhamdhere, *Operating Systems: A Concept-Based Approach*, New Delhi, India: Tata McGraw-Hill, 2006,2nd Edition.
5. W. Stallings, *Operating Systems: Internals and Design Principles*, Boston, MA, USA: Pearson Education, 2012,7th Edition.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc21_cs72/preview
2. https://www.coursera.org/specializations/codio-introduction-operating-systems

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	1	1	2	3						1	1	
CO2	2	3	2	1	1							1	2
CO3	2	2	1	1	2						2	2	1
CO4	2	1	2	3	2							1	

Program	B. Tech CSE (CCML)				
Year	II	**Semester**	IV		
Course Name	Data Structures Using 'C'				
Code	RCS5403				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamentals of computer knowledge	3	1	0	4
Course Objectives	1. To introduce the basis and advanced data structures 2. To understand various data operations performed on in data structures 3. To understand various sorting and searching techniques in data structures 4. To analyse the performance of data structures algorithms				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching and sorting of each data structure.				
CO2	Apply knowledge of underlying data structures needed for solving problems and programming.				
CO3	Analyse the application of data structures for storage and retrieval of ordered and unordered data.				
CO4	Understanding the graph representation and traversal				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction** Introduction: Basic Terminology, Data types and its classification, Algorithm complexity notations like big Oh, Time- Space trade-off. Abstract DataType (ADT). **Array**: Array, Definition, Representation and Analysis of Arrays, Single and Multidimensional Arrays, Address calculation, Array as Parameters, Sparse Matrices, Recursion- definition and processes, simulating recursion, Backtracking, Recursive algorithms, Tail recursion, Removal of recursion, Tower of Hanoi.	15 Hours	CO1
2	**Stack and Linked List** Stack, Array Implementation of stack, Linked Representation of Stack, Application of stack: Conversion of Infix to Prefix and Postfix Expressions and Expression evaluation, Queue, Array and linked implementation of queues, Circular queues, D-queues and Priority Queues. Linked list, Implementation of Singly Linked List, Two-way Header List, Doubly linked list, Linked List in Array. Generalized linked list, Application: Garbage collection and compaction.	15 Hours	CO2

3	**Tree, Searching, Sorting and Hashing** Trees: Basic, terminology, Binary Trees, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Binary Search Tree (BST), AVL Trees, B-trees. Application: Algebraic Expression, Internal and External sorting, Insertion Sort, Bubble Sort, selection sort, Quick Sort, Merge Sort, Heap Sort, Radix sort, Searching Hashing: Sequential search, binary search, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation.	15 Hours	CO3
4	**Graphs:** Graphs: Terminology, Sequential and linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi-list, Graph Traversal: Depth First Search and Breadth First Search, Connected Component, Spanning Trees, Minimum Cost Spanning Trees: Prims and Kruskal algorithm. Transitive Closure and Shortest Path algorithm: Warshall Algorithm and Dijkstra Algorithm.	15 Hours	CO4

Suggested Readings

1. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein, "Data Structures Using C and C++", PHI, 2000,2nd Edition.
2. Horowitz and Sahani, "Fundamentals of Data Structures", Galgotia Publication, 1982, 1st Edition.
3. Jean Paul Trembley and Paul G. Sorenson, "An Introduction to Data Structures with Applications", McGraw-Hill, 1984,2nd Edition.
4. R. Kruse et al., "Data Structures and Program Design in C", Pearson Education, 2006, 2nd Edition.
5. Lipschutz, "Data Structures", Schaum's Outline Series, TMH, 2014,1st Edition.
6. GAV Pai, "Data Structures and Algorithms", TMH, 2009, 1st Edition.

Online Resources

1. https://archive.nptel.ac.in/courses/106/102/106102064/
2. Lecture Videos | Introduction to Algorithms | Electrical Engineering and Computer Science | MIT Open Course Ware

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2	1									1	
CO2	1	1	2									1	
CO3	2	1	2									1	
CO4	2	2	2									1	

Program	B. Tech. CSE(CCML)				
Year	III	**Semester**	IV		
Course Name	Cloud Computing Lab				
Code	RCCML5452				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Cloud Computing, and Programming fundamentals.	0	0	2	1
Course Objectives	1. To understand the concepts, characteristics, and deployment models of Cloud Computing and AWS Cloud services. 2. To learn cloud application deployment, serverless computing, and cloud resource management using AWS services. 3. To understand DevOps practices, version control systems, and CI/CD pipeline automation using Git and GitHub Actions. 4. To develop RESTful APIs and implement containerization and orchestration using Docker and Kubernetes.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the fundamentals of Cloud Computing, cloud service models, deployment models, and AWS global infrastructure.				
CO2	Apply AWS cloud services such as EC2, S3, Elastic Beanstalk, and Lambda for cloud application deployment and management.				
CO3	Implement DevOps practices including version control, repository management, and CI/CD automation using Git and GitHub Actions.				
CO4	Develop REST APIs and deploy containerized applications using Docker and Kubernetes orchestration tools.				

S. No.	List of Experiments	Mapped CO
1	Getting started with registration of IBM Cloud.	CO1
2	Text to speech Watson service of IBM cloud using Node.js	CO1
3	Speech to text Watson service of IBM cloud using Node.js	CO1
4	Develop node js application and deploy through AWS through elastic beanstalk.	CO2
5	Develop node js app and deploy on AWS through code pipeline.	CO2

6	Deploying a Simple Node.js Express App on AWS Elastic Beanstalk with Code Pipeline.	CO2
7	Install Git and perform basic Git commands such as clone, add, commit, and push.	CO3
8	Create and manage a GitHub repository with branching and merging operations.	CO3
9	Create a simple CI/CD workflow using GitHub Actions for automatic application deployment.	CO3
10	Integrate third party application (Postman) with Cloud ant application.	CO4
11	Create and run Docker containers for a Node.js application using Dockerfile.	CO4
12	Build Chatbot applications for more than one sector Using Watson Assistant	CO4

Suggested Readings

1. T. Erl, *Cloud Computing: Concepts, Technology & Architecture*, Boston, MA, USA: Pearson Education, 2013, 1st Edition.
2. B. Piper, *AWS Certified Cloud Practitioner Study Guide*, Hoboken, NJ, USA: Wiley, 2019,1st Edition.
3. M. Krief, *Learning DevOps*, Birmingham, UK: Packt Publishing, 2019,1st Edition.
4. N. Poulton, *Docker Deep Dive*, Birmingham, UK: Packt Publishing, 2020,5th Edition.

Online Resources

1. https://aws.amazon.com/getting-started/
2. https://docs.aws.amazon.com/

Course Articulation Matrix

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	2	2	1	2				1	2		2	2
CO 2	3	2	3	2	2	1	1		2	2	3	2	2
CO 3	2	2	2	1	2			1	3	2	2	2	3
CO 4	3	3	3	2	2	1	1	1	2	2	2	2	2

Program	B.Tech. CSE(CCML)					
Year	II	**Semester**	IV			
Course Name	Operating System Lab					
Course Code	RCS5454					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Familiarity with Linux/Unix Operating Environment	0	0	2	1	
Course Objectives	1. To familiarize students with the UNIX/Linux environment, system calls, and fundamental operating system services. 2. To develop the ability to design, implement, and analyze process management, CPU scheduling, synchronization, and deadlock handling techniques. 3. To provide practical knowledge of memory management mechanisms, including memory allocation, virtual memory, and page replacement algorithms. 4. To enable students to understand and evaluate file system organization, file allocation methods, and disk scheduling techniques for efficient resource utilization.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Demonstrate the use of UNIX/Linux commands and system calls for managing processes and system resources.					
CO2	Implement and evaluate CPU scheduling, process synchronization, and deadlock management algorithms in operating systems.					
CO3	Apply memory management techniques, including memory allocation, virtual memory, and page replacement algorithms, to solve resource management problems.					
CO4	Analyze and implement file allocation and disk scheduling algorithms for efficient storage and I/O management.					

S. No.	List of Experiments	Mapped CO
1	UNIX/Linux Commands and System Calls	CO1
2	CPU Scheduling (FCFS, SJF)	CO2
3	Producer–Consumer using Semaphores	CO2
4	Banker's Algorithm for Deadlock Avoidance	CO2
5	Deadlock Prevention Techniques	CO2
6	Memory Allocation (First Fit, Best Fit, Worst Fit)	CO3
7	Page Replacement (FIFO, LRU)	CO3
8	Virtual Memory Management using Paging and Address Translation	CO3
9	File Allocation Strategies (Sequential, Indexed, Linked)	CO4
10	Disk Scheduling Algorithms (FCFS, SCAN, C-SCAN)	CO4

Online Resources:

1. IIT Interactive Simulation Portal: https://iitinteractives.com/operating-system-simulator/
2. KodeKloud Free Linux Lab Environment: https://kodekloud.com/free-labs/linux/

3. Virtual Labs – Operating Systems Laboratory: https://os-iiith.vlabs.ac.in/
4. MIT Operating System Engineering Laboratory Resources: https://pdos.csail.mit.edu/6.828/

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2	2	1	2								2
CO2	3	3	2	2	1								1
CO3	3	3	3	2	1								2
CO4	3	3	3	2	1								2

Program	B.Tech CSE (CCML)				
Year	II	**Semester**	IV		
Course Name	Data Structure Using 'C' Lab				
Code	RCS5453				
Course Type	PCC	L	T	P	Credit
Pre-Requisite	Basic knowledge of C language	0	0	2	1
Course Objectives	1. Understand various data representation techniques in the real world. 2. Implement linear and non-linear data structures. 3. Analyze various algorithms based on their time and space complexity. 4. Develop real-time applications using suitable data structure.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the concept of data structures and apply algorithm for solving problems like Sorting, searching, insertion and deletion of data.				
CO2	Explore various operations on dynamic data structures like single linked list, circular linked list and doubly linked list.				
CO3	Construct and perform operations on binary trees and binary search trees, including insertion, deletion, and traversal techniques.				
CO4	Implement graph traversal algorithms such as Breadth First Search (BFS) and Depth First Search (DFS) for graph-based problem solving.				

S. No.	List of Experiments	Mapped CO
1	Implementation of Searching and Sorting Algorithms.	CO1
2	Implementation of Singly Linked List	CO2
3	Implementation of Stack using Array.	CO2
4	Implementation of Queue using Array.	CO2
5	Implementation of Circular Queue using Array.	CO2
6	Implementation of Stack using Linked List.	CO2
7	Implementation of Queue using Array.	CO2
8	Implementation of Binary Tree.	CO3
9	Implementation of Tree Traversal.	CO3
10	Implementation of Binary Search Tree.	CO3
11	Implementation of insertion and deletion in BST.	CO3
12	Implementation of Graph traversal using BFS & DFS.	CO4
13	Graph Implementation of Minimum cost spanning tree.	CO4
14	Graph Implementation of shortest path algorithm.	CO4

Online Resources

1. https://cse01-iiith.vlabs.ac.in/
2. https://cse.iitkgp.ac.in/~rkumar/pds-vlab/index1.html

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	2	2	1							1	1
CO2	2	2	1	1									
CO3	2	2	2	3	2								
CO4	2	3	2	2	1							1	1

Program	B.Tech CSE (CCML)				
Year	II	**Semester**	IV		
Course Name	Indian Constitution				
Code	RMC5401				
Course Type	MC	**L**	**T**	**P**	**Credit**
Pre-Requisite	The basic knowledge of Indian Constitutions	1	0	0	1
Course Objectives	1. To realize the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution. To Know the need and importance of protecting traditional. 2. To identify the importance of fundamental rights as well as fundamental duties. 3. To understand the functioning of Union, State and Local Governments in Indian federal system. 4. To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the concept of Indian constitution.				
CO2	Identify the powers and functions of Supreme Court and High court.				
CO3	Analyze the role Governor and Chief Minister.				
CO4	Explain the district administration role and importance.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Indian Constitution:** Constitution meaning of the term - The making of the Indian Constitution - Sources and constitutional history – Philosophy of Constituent Assembly - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy. Union Government and its Administration Structure: President and Vice President: Role, power and position, PM and Council of ministers, Cabinet and	7 Hours	CO1, CO2

	Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions.		
2	**The States and The Union Territories:** State Government and its Administration: Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions – Relation between the Union and the States. **Local Administration:** District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative – Panchayati Raj: Functions PRI: Zillah Panchayat, Elected officials and their roles - Block level Organizational Hierarchy, Village level - Role of Elected and Appointed officials - Importance of grass-root democracy	8 Hours	CO3, CO4

Suggested Readings

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd., New Delhi.
2. Subash Kashyap, Indian Constitution, National Book Trust.
3. J. A. Siwach, Dynamics of Indian Government & Politics.
4. D. C. Gupta, Indian Government and Politics.
5. H. M. Sreevai, Constitutional Law of India, 4th Edition, Universal Law Publication.

Online Resources

1. https://onlinecourses.nptel.ac.in/noc20_lw03/preview

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1		2					2	3	1	2		1	
CO2		3					1	2	3	2		2	
CO3		1					2	2	2	1		1	
CO4		2					1	3	2	2		2	

Program	B. Tech CSE (AI)					
Year	III	**Semester**	V			
Course Name	Essence of Indian Knowledge Tradition					
Course Code	RMC5501					
Course Type	MC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	To introduce the concepts of the Indian Traditional Knowledge System and help students understand the importance of the roots of the knowledge system.	1	0	0	1	
Course Objectives	1. To understand the concept of Traditional knowledge and its importance.					
	2. To know the need and importance of protecting traditional.					
	3. To apply, Know the various enactments related to the protection of traditional knowledge.					
	4. To understand the concepts of Intellectual property to protect the traditional.					
Course Outcomes: After successful completion of the course, the student will be able to:						
CO1	To Understand and elucidate the basic knowledge of traditional knowledge to develop the physical and social changes in traditional knowledge systems.					
CO2	To Analyse the significance of traditional knowledge protection to communicate the traditional knowledge information					
CO3	To Apply to Recognize the role of government on traditional knowledge to measure its impact on the global economy.					
CO4	To Evaluate and Summarize the strategies of patents and global legal FORA for excel protection of Indian traditional knowledge					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Traditional Knowledge:** Understanding the concept and significance of Indian Traditional Knowledge, Historical background, and evolution of traditional knowledge in India. **Intellectual Property Rights (IPR):** Overview of Intellectual Property Rights and its importance in the context of traditional knowledge.	7 Hours	CO1

	Different types of IPRs: Copyright, Trademarks, Patents, and Geographical Indications. **Traditional Knowledge and Traditional Cultural Expressions (TCEs):** Introduction to Traditional Cultural Expressions and the challenges in their protection, Examination of international frameworks like the WIPO Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge, and Folklore. Traditional Knowledge and Traditional Ecological Knowledge (TEK) Understanding the relationship between traditional knowledge and traditional ecological knowledge, Analysis of the role of TEK in environmental conservation and sustainable development.		
2	**Traditional Knowledge and IPR Laws In India***:* Study of the legal framework for the protection of traditional knowledge in India, Examination of relevant laws and regulations, such as the Traditional Knowledge Digital Library (TKDL), Traditional Knowledge and Patent Law: Understanding the challenges and issues surrounding the patenting of traditional knowledge, Analysis of case studies highlighting the controversies and debates in the field. **Traditional Knowledge and Copyright Law:** Exploring the relationship between traditional knowledge and copyright law, Discussion on the issues of cultural appropriation and protection of traditional expressions. **Traditional Knowledge and Geographical Indications (GI):** Overview of Geographical Indications and their significance in protecting traditional knowledge, Case studies on the successful registration and protection of traditional products and practices. **Traditional Knowledge, IPR, and the Future:** Analysis of the current trends and future prospects for the protection and preservation of Indian traditional knowledge, Examination of emerging issues such as digital platforms and traditional knowledge dissemination.	8 Hours	CO2

Suggested Readings

1. Jha, Amit. *Traditional Knowledge System in India*. 2009.
2. Mohanta, Basanta Kumar, and Vipin Kumar Singh. *Traditional Knowledge System and Technology in India*. Pratibha Prakashan, 2012.
3. Jha, Amit. *Traditional Knowledge System in India*. Atlantic Publishers, 2002.
4. Sampath, P. G. *Traditional Knowledge Systems and Intellectual Property Rights*. Routledge, 2012.
5. Sharma, G., and V. Kumar (Eds.). *Indian Traditional Knowledge and Intellectual Property Rights: Innovations in Traditional Knowledge Preservation*. Springer, 2016.
6. Ganguli, Prabuddha. *Indian Traditional Knowledge and Intellectual Property Rights: Indigenous Community Initiatives*. Ane Books Pvt. Ltd., 2010.

Online Resources

1. https://aec.edu.in/knowledge/
2. https://www.iare.ac.in/?q=node/3745

	Course Articulation Matrix												
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1								1	2	2	2		1
CO2								2	2	4	3		2
CO3								1	1	4	2		2
CO4								2	2	3	1		2

Program	B. Tech CSE (CCML)					
Year	III	**Semester**	V			
Course Name	Automata Theory and Formal Languages					
Code	RCS5501					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Discrete Mathematics, Data Structure	3	1	0	4	
Course Objectives	1. To illustrate finite state machines to solve problems in computing 2. To explain the hierarchy of problems arising in the computer sciences. 3. To familiarize Regular grammars, context frees grammar. 4. To determine the decidability and intractability of computational problems.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Apply the knowledge of automata theory, grammars & regular expressions for solving the problem					
CO2	Analyze the give automata, regular expression & grammar to know the language it represents					
CO3	Design Automata & Grammar for pattern recognition and syntax checking.					
CO4	Identify limitations of some computational models and possible methods of proving them					

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals:** Formal Languages, Strings, Alphabets, Languages, Chomsky Hierarchy of languages. Finite Automata: Introduction to Finite State machine, Acceptance of strings and languages, Deterministic finite automaton (DFA) and Non-deterministic finite automaton (NFA), Equivalence of NFA and DFA – Equivalence of NDFAs with and without €-moves, Minimization of finite automata, Equivalence between two DFA's, Finite automata with output – Moore and Mealy machines, conversion of Moore to Mealy and Mealy to Moore.	15 Hours	CO1
2	**Regular Languages:** Regular expressions, Identity rules, Conversion of a given regular expression into a finite automaton, Arden's Theorem. Conversion of finite automata into a regular expression, Pumping lemma for regular sets, Closure properties of regular sets. **Context Free Grammars:** Context free grammars and languages, Derivation trees, Leftmost and rightmost derivation of strings and Sentential forms, Ambiguity, left recursion and left factoring in context free grammars, Minimization of context free grammars, Normal forms for context free grammars, Chomsky normal form(CNF), Greibach normal form(GNF), Pumping Lemma for Context free Languages, Closure and decision properties of context free languages.	15 Hours	CO2
3	**Pushdown Automata:** Introduction to Pushdown automata, Acceptance of context free languages, Acceptance by final state and acceptance by empty state and its equivalence,	15 Hours	CO3

	Types of PDA, Equivalence of context free grammars and pushdown automata, Inter-conversion, Two Stack PDA.		
4	**Turing Machine (TM):** Introduction to Turing machine, Basic Turing Machine Model, Turing Machine Representation, Instantaneous Description of Turing Machine, Turing Machine as Computer of Integer function, Language Acceptability of Turing Machine, Modifications of Turing Machine, Church's Thesis, Recursive and Recursive Enumerable Languages ,Definition of Post's Correspondence Problem, Undecidable Problem that Is RE, Context sensitive languages and Chomsky hierarchy, Halting Problem.	15 Hours	CO4

Suggested Readings

1. John C. Martin, Introduction to Languages and Automata Theory, Tata McGraw-Hill, 3rd Edition, 2007.
2. Daniel I. A. Cohen, Introduction to Computer Theory, John Wiley & Sons, 2nd Edition, 1996.
3. Marvin L. Minsky, Computation: Finite and Infinite Machines, Prentice-Hall, Reprint Edition, 1972.

Online Resources

1. NPTEL, Theory of Computation, IIT Kanpur. Available at: https://nptel.ac.in/courses/106104028.
2. Stanford Online, Automata Theory (Self-Paced). Available at: https://www.edx.org/learn/coding/stanford-university-automata-theory.
3. NPTEL, Theory of Automata and Formal Languages, IIT Guwahati. Available at: https://nptel.ac.in/courses/106103070.

Course Articulation Matrix

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	1						1	2	1
CO2	3	3	2	2	1						2	1	1
CO3	3	3	2	2	2						2	3	1
CO4	3	2	1	1	2						2	2	1

Program	B. Tech. CSE (CCML)				
Year	III	**Semester**	V		
Course Name	Predictive Analytics				
Code	RCS5505				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of basic linear algebra, calculus, probability and statistics..	3	1	0	4
Course Objectives	1. To provide an overview of an exciting field of Predictive Analytics. 2. To introduce the tools required For Predictive Analytics. 3. Explore data to look at data distributions and to identify data Problems, including missing values. 4. To enable students to have skills that will help them to solve complex Real-world problems in decision support.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand data analytics and its application.				
CO2	Analyze the concepts of unit of analysis and its objective.				
CO3	Evaluate the predictive analytics with IBM Watson Studio.				
CO4	To understand and apply IBM SPSS Modeller in Data Mining, what kinds of data can be mined, and what kinds of patterns can be mined.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**ANALYTICS OVERVIEW:** Definition of business Analytics with real-time examples, How Predictive analytics works: Transforming data into future insights, Analytics trends: Past, Present and Future, Towards a Predictive enterprise. **IBM SPSS MODELER & DATA MINING:** What are Data Mining applications? Strategy for data mining: CRISP-DM, Identify nodes and streams, The framework of a Data – mining project, Brief the unit of analysis, Explain the type of dialog box.	15 Hours	CO1
2	**UNIT OF ANALYSIS:** Concepts of Unit of analysis (Distinct, Aggregate, SetToFlag), Integrate data, CLEM Expression, Role of	15 Hours	CO2

	Relationship between two fields, Identifying the modelling objective.		
3	**PREDICTIVE ANALYTICS WITH IBM WATSON STUDIO:** IBM Watson Studio, Watson studio Components, Data preparation, Watson Machine learning, Data Refinery, Watson Studio Neural Network Modeler, IBM Watson Studio jobs, Use case with AutoAI.	15 Hours	CO3
4	**PROJECT:** Predicting using IBM SPSS Modeler & IBM Watson with real Case studies	15 Hours	CO4

Suggested Readings:

1. IBM, *IBM Courseware*, IBM Corp., 2015.
2. E. Siegel, *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die*, Hoboken, NJ, USA: Wiley, 2013,1st Edition.

Online Resources:

1. https://nptel.ac.in/courses/110104086
2. https://archive.nptel.ac.in/courses/111/106/111106164/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	2	2							2		2
CO2	2	2	2		1						2	1	
CO3	2	1	1	2	2						2	2	2
CO4	2	2	1	2	2						2	2	1

Program	B. Tech. CSE (CCML)					
Year	III	**Semester**	V			
Course Name	DevOps					
Code	RCCML5501					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic knowledge of Operating Systems, Computer Networks, Cloud, Linux, and Programming fundamentals.	2	1	0	3	
Course Objectives	1. Understand the fundamentals of DevOps, Agile methodologies, Scrum framework, and collaborative software development practices.					
	2. Apply version control systems, GitHub repository management, and CI/CD pipeline concepts for software integration and deployment.					
	3. Implement containerization and orchestration techniques using Docker and Kubernetes for scalable application deployment.					
	4. Analyze cloud computing concepts, infrastructure automation, monitoring tools, and DevOps deployment practices using Terraform, Ansible, and cloud platforms.					
Course Outcomes: After successful completion of the course, the student will be able to:						
CO1	Apply knowledge of computing fundamentals, software engineering, and DevOps practices to solve real-world problems.					
CO2	Design and develop automated software delivery pipelines and scalable cloud-native applications using modern DevOps tools.					
CO3	Utilize modern IT infrastructure, containerization, cloud computing, and orchestration technologies for efficient deployment and management of applications.					
CO4	Analyze professional, ethical, security, and operational challenges in DevOps environments while ensuring continuous improvement and system reliability.					

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to DevOps:** Evolution of DevOps, Benefits and Challenges of DevOps, Software Development Life Cycle (SDLC), Agile Methodology, Agile vs Waterfall Model, Scrum Framework, Scrum Roles and Artifacts, Introduction to Design Thinking,	15 Hours	CO1

	Collaboration and Communication in DevOps.		
2	**Introduction to Version Control Systems:** Git Fundamentals, GitHub Repository Management, Branching and Merging Strategies, Continuous Integration (CI), Continuous Deployment (CD), Building CI/CD Pipelines using GitHub Actions, Automated Testing Concepts, and Pipeline Automation Best Practices.	15 Hours	CO2
3	**Introduction to Containerization:** Docker Architecture, Docker Installation and Commands, Docker Images and Containers, Dockerfile and Docker Compose, Container Networking and Volumes, Introduction to Kubernetes, Kubernetes Architecture, Pods, Deployments and Services, Scaling and Managing Applications using Kubernetes. **Introduction to Cloud Computing:** Definition and Characteristics of Cloud Computing, benefits of cloud computing, IBM Cloud fundamentals and resources, DevOps Security Best Practices, Virtualization and Containers including VMs vs Containers, Serverless Computing using AWS Lambda and IBM Cloud Functions, Edge Computing, and End-to-End DevOps Project Deployment.	15 Hours	CO3, CO4

Suggested Readings

1. IBM, *Agile Development and Methodologies*, IBM Courseware, 2015.
2. A. Maurya, *Running Lean: Iterate from Plan A to a Plan That Works*, Sebastopol, CA, USA: O'Reilly Media, 2012, 2nd Edition.
3. J. Sutherland, *Scrum: The Art of Doing Twice the Work in Half the Time*, New York, NY, USA: Crown Business, 2014,1st Edition.
4. G. Kim, K. Behr, and G. Spafford, *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*, Portland, OR, USA: IT Revolution Press, 2013,1st Edition.

Online Resources

1. https://www.azuredevopslabs.com/
2. https://www.youtube.com/@nptel-speciallectureseries6651

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3	2	2	1	2				1	2		2	2
CO 2	3	2	3	2	2	1	1		2	2	3	2	2
CO 3	2	2	2	1	2			1	3	2	2	2	3
CO 4	3	3	3	2	2	1	1	1	2	2	2	2	2

Program	B. Tech CSE (CCML)				
Year	III	**Semester**	V		
Course Name	Computer Networks				
Course Code	RCS5502				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of Computer Operations	2	1com	0	3
Course Objectives	1. To understand the organization of computer networks with the concept of layered approach				
	2. To understand the working of computer networks hardware like LAN, Switch, Hub etc.				
	3. To understand the concept of data communication				
	4. To understand the concept of various routing and protocols used in data communication				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain basic concepts of OSI reference model and TCP/IP model and networks devices and transmission media, Analog and digital data transmission.				
CO2	Be able to describe the functions of Data link layer and Network layer.				
CO3	Be able to describe the functions of Transport, Session Layer.				
CO4	Be able to describe the functions of Presentation and Application Layer.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Fundamentals of Computer Networks & Physical Layer** **Introduction to Networks: Network** objectives and applications, Network structure and architecture, Examples of computer networks **Reference Models:** OSI Reference Model (layer-wise functions), TCP/IP Model and comparison with OSI **Physical Layer Concepts:** Transmission media (guided and unguided), Analog transmission, Digital transmission, Switching techniques (circuit, packet, message switching), ISDN basics, Terminal handling **Broadcast Channels & LAN Basics:** Medium access control principles, LAN protocols overview	15 Hours	CO1
2	**Data Link Layer & Network Layer** Design issues, Error detection and correction (CRC, Hamming code, etc.), Elementary data link protocols, Sliding window protocols **MAC & LAN Technologies:** CSMA with Collision Detection (CSMA/CD), Collision-free protocols, IEEE 802 standards for LANs, Comparison of LANs (Ethernet, Token Ring, etc.), Fiber optic networks and FDDI **Network Layer:** Design issues, Routing algorithms (shortest path, distance vector, link state), Congestion control techniques, Internetworking concepts and Examples	15 Hours	CO2
3	**Transport to Application Layer** **Transport Layer:** Design issues, Connection management (establishment and release), Example of a simple transport protocol	15 Hours	CO3, CO4

	Session Layer: Design issues, Remote Procedure Call (RPC), Examples **Presentation Layer:** Design issues, Data compression techniques, Encryption basics, Network security and privacy concepts **Application Layer:** Design issues, File transfer and file access (FTP concepts), Electronic mail (Email protocols basics), Virtual terminals, other network applications		

Suggested Readings

1. B.A. Frozen "Data Communication and Networking". Tata McGraw Hill.5th Edition, 2013.
2. Andrew S. Tanenbaum "Computer Networks" Prentice Hall of India. 5th Edition, 2011.
3. William Stallings "Local Networks" Maxwell Macmillan International Edition,3rd Edition,1990.

Online Resources

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs35

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	1										1	
CO2	2	1	1									1	
CO3	2	1	1									1	
CO4	2	1	1								1	1	

Program	B.Tech. CSE(CCML)				
Year	III	**Semester**	V		
Course Name	Predictive Analytics Lab				
Code	RCS5555				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of Data Mining	0	0	2	1
Course Objectives	1. Developing a predictive model and improving business outcomes. 2. Exploring new data sources. 3. Implementing predictive models. 4. Evaluating model performance.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Implement social media data using appropriate data/web mining techniques.				
CO2	Demonstrate Structured Data Extraction.				
CO3	Design a system to harvest information available on the web to build recommender systems.				
CO4	Implement the different components of a web page that can be used for mining.				

S. No.	List of Experiments	Mapped CO
1	Create a data-mining project to predict churn in telecommunications.	CO2
2	Demonstrate the Integration of telecommunications data using IBM SPSS Modeller.	CO3
3	Demonstrate the Derive and reclassify fields for the telecommunications data.	CO1
4	Predict churn in telecommunications and cluster customers into segments.	CO2
5	Demonstrate linear regression analysis by predicting the target (amount of waste produced) as a function of several related inputs (amount of acreage put to different uses).	CO4
6	Predicting real use cases using an SVM Model.	CO3
7	Predicting real use cases using Cox Regression.	CO3
8	Implementation of Model Bagging Using Neural Net.	CO4
9	Forecasting for a national broadband provider who wants to produce forecast so fuser subscriptions in order to predict bandwidth usage.	CO3
10	Implementation of Error or Fraud Detection in Claims.	CO2
11	Predicting Credit Risk using Logistic Regression.	CO4

Suggested Readings:

1. IBM, *IBM Courseware*, IBM Corp., 2015.

2. E. Siegel, *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die*, Hoboken, NJ, USA: Wiley, 2013,1st Edition.

Online Resources:

1. https://www.iiitmk.ac.in/DAVirtalLab/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2									1	1	1
CO2	3	2		1							1	2	2
CO3	3	2						2			1	2	2
CO4	3	1				1					1	2	2

Program	B. Tech. CSE (CCML)				
Year	III	**Semester**	V		
Course Name	DevOps Lab				
Code	RCCML5551				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Operating Systems, Linux Commands, Cloud Computing, and Programming fundamentals.	0	0	2	1
Course Objectives	1. Understand the basic concepts of DevOps, Agile methodologies, Linux environment, and version control systems. 2. Apply Git and GitHub tools to manage repositories, branching, merging, and CI/CD workflows. 3. Implement containerization and orchestration using Docker, Docker Compose, and Kubernetes tools. 4. Demonstrate cloud deployment, infrastructure automation, and monitoring techniques using cloud platforms, Terraform, Prometheus, and Grafana.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply modern DevOps tools and techniques to automate software development and deployment processes.				
CO2	Design and manage scalable cloud-native applications using containerization and orchestration technologies.				
CO3	Utilize cloud computing and infrastructure automation tools for efficient deployment and system management.				
CO4	Analyze and implement monitoring, security, and operational best practices in DevOps environments.				

S. No.	List of Experiments	Mapped CO
1	Installation and configuration of the Linux operating system in a virtual machine.	CO1
2	Create a GitHub account and perform basic Git commands such as git in it, git add, git commit, and git push.	CO1

3	Create a simple Agile project workflow including Scrum roles, sprint planning, and task management using GitHub Projects or Trello.	CO1
4	Create and manage a GitHub repository with branching and merging operations.	CO2
5	Implement Continuous Integration workflow using GitHub Actions for a sample application.	CO2
6	Perform automated build and testing using GitHub Actions CI/CD pipeline.	CO2
7	Install Docker and execute basic Docker commands.	CO3
8	Create and run Docker containers using Dockerfile and Docker Compose.	CO3
9	Install Minikube and deploy a simple application on Kubernetes using Pods and Deployments.	CO3
10	Create and manage an EC2 virtual machine instance on IBM Cloud or AWS Cloud.	CO4
11	Provision infrastructure using Terraform for cloud resource deployment.	CO4
12	Configure monitoring and visualization using Prometheus and Grafana for a sample application deployment.	CO4

Suggested Readings

1. Kim, K. Behr, and G. Spafford, *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*, Portland, OR, USA: IT Revolution Press, 2013, 1st Edition.
2. S. Yadapalli, *Hands-On DevOps with Linux*, Birmingham, UK: Packt Publishing, 2018, 1st Edition.

Online Resources

1. https://docs.docker.com/
2. https://kubernetes.io/docs/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3	2	2	1	2				1	2		2	2
CO 2	3	2	3	2	2	1	1		2	2	3	2	2
CO 3	2	2	2	1	2			1	3	2	2	2	3
CO 4	3	3	3	2	2	1	1	1	2	2	2	2	2

Program	B. Tech CSE (CCML)				
Year	III	**Semester**	V		
Course Name	Computer Networks Lab				
Code	RCS5552				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic of Networking.	0	0	2	1
Course Objectives	1. Understanding the concepts of Networking. 2. Studying about different Stuffing Concepts. 3. Gaining knowledge of different Topologies. 4. Applying the various concepts in the real world.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the concepts of Network Cables and Network Commands.				
CO2	Analyze the use of Local Area Networks.				
CO3	Evaluate the performance of different programs related to Networking.				
CO4	Design and Apply different Topologies through simulation.				

S. No.	List of Experiments	CO Mapping
1	Study of different type of Network cables and practically implement the cross wired cable.	CO1
2	Study and implementation of basic network command and network configuration commands.	CO1
3	Connect the computers in local area network.	CO2
4	To write a socket program for implementation of echo.	CO2
5	Write a program in C to perform character stuffing.	CO3
6	Write a program in C to perform Bit stuffing.	CO3
7	Implement CRC (Cyclic redundancy check) in C.	CO3
8	Write a program in C to implement sliding window protocol.	CO3
9	To create Scenario and Study the performance of Ring topology through simulation.	CO4
10	To create Scenario and Study the performance of Bus topology through simulation.	CO4

Online Resources

1. http://vlabs.iitkgp.ac.in/ant/1/

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2	1	2						1	2	1
CO2	2	3	2	2	1						1	2	3
CO3	3	2	2	1	3						1	3	2
CO4	3	2	2	1	2						2	3	1

Program	B. Tech CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Compiler Design				
Code	RCS5604				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Automata Theory	3	1	0	4
Course Objectives	1. To apply the theory of language translation to build compilers and interpreters. 2. Building of translators both from scratch and using compiler generators. 3. Identifies and explores the main issues of the design of translators. 4. The construction of a compiler/interpreter for a small language				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand different phases and passes of the compiler and use the compiler tools like LEX, YACC, etc.				
CO2	Analyse the concepts of parser and its types.				
CO3	Understanding translation and applying it.				
CO4	Applying code generation and optimization on target machine				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Compiler:** Phases and passes, Bootstrapping, Finite state machines and regular expressions and their applications to lexical analysis, Optimization of DFA-Based Pattern Matchers implementation of lexical analyzers, lexical-analyzer generator, LEX compiler, Formal grammars and their application to syntax analysis, BNF notation, ambiguity, YACC. The syntactic specification of programming languages: Context free grammars, derivation and parse trees, capabilities of CFG. **Basic Parsing Techniques:** Parsers, Shift reduce parsing, operator precedence parsing, top down parsing, predictive parsers.	15 Hours	CO1
2	**Automatic Construction of efficient Parsers:** LR parsers, the canonical Collection of LR (0) items, constructing SLR parsing tables, constructing Canonical LR parsing tables, Constructing LALR parsing tables, using ambiguous grammars, an automatic parser generator, implementation of LR parsing tables. Parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top down parser.	15 Hours	CO2, CO3
3	**Syntax-directed Translation:** Syntax-directed Translation schemes, Implementation of Syntax directed Translators, Intermediate code, postfix notation. **More about translation:** Array references in arithmetic expressions, procedures call, declarations and case	15 Hours	CO3

	statements. **Symbol Tables:** Data structure for symbols tables, representing scope information. Run-Time Administration: Implementation of simple stack allocation scheme, storage allocation in block structured language.		
4	**Error Detection & Recovery:** Lexical Phase errors, syntactic phase errors semantic errors. **Code Generation:** Design Issues, the Target Language. Addresses in the Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, Code Generator. Code optimization: Machine-Independent Optimizations, Loop optimization, DAG representation of basic blocks, value numbers and algebraic laws, Global Data-Flow analysis.	15 Hours	CO4

Suggested Readings

1. Aho, Sethi& Ullman, "Compilers: Principles, Techniques and Tools", Pearson Education.
2. K. Muneeswaran,CompilerDesign,FirstEdition,Oxford University Press.
3. J.P. Bennet, "Introduction to Compiler Techniques", Second Edition, McGraw-Hill,2003.
4. HenkAlblas and Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001.
5. V Raghvan, "Principles of Compiler Design", McGraw-Hill.
6. Kenneth Louden," Compiler Construction", Cengage Learning.
7. Charles Fischer and Ricard LeBlanc," Crafting a Compiler with C", Pearson Education.

Online Resources

1. https://nptel.ac.in/courses/106104123
2. https://nptel.ac.in/courses/106105190

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	1	1						1	2	
CO2	3	3	2	1	2						2	1	
CO3	3	3	2	2	3						2	2	
CO4	3	2	1	1	1						1	1	

Program	B.Tech CSE (CCML)					
Year	III	Semester	VI			
Course Name	Machine Learning					
Course Code	RCCML5601					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic knowledge of Python Programming Language.	3	1	0	4	
Course Objectives	1. To provide a strong foundation in Machine Learning concepts, techniques, and applications. 2. To develop proficiency in Python programming for data analysis and visualization. 3. To apply supervised and unsupervised learning algorithms to real-world datasets. 4. To evaluate machine learning models and develop effective data-driven solutions.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Understand Machine Learning fundamentals, data preprocessing, and Python tools for ML applications.					
CO2	Analyze and visualize data to derive meaningful insights.					
CO3	Apply supervised machine learning algorithms to solve real-world problems.					
CO4	Implement and evaluate unsupervised learning and neural network techniques for data-driven decision making.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Machine Learning Foundations and Python Programming:** Introduction to Artificial Intelligence, Machine Learning and Data Science, Types of Machine Learning (Supervised, Unsupervised and Reinforcement Learning), Applications of Machine	15 Hours	CO1

	Learning, Introduction to Python ecosystem for Machine Learning, NumPy and Pandas basics, Data collection and understanding, Data cleaning and preprocessing, Feature scaling, Normalization and Standardization, Train-Test Split and Cross Validation.		
2	**Exploratory Data Analysis and Statistical Foundations:** Data visualization using Matplotlib and Seaborn, Scatter Plot, Line Chart, Bar Chart, Histogram, Box Plot and Heat Map, Measures of Central Tendency, Variance and Standard Deviation, Correlation and Covariance, Hypothesis Testing, Missing Value Treatment, Outlier Detection, Data Encoding Techniques and Feature Engineering for Machine Learning	15 Hours	CO2
3	**Supervised Machine Learning Techniques:** Regression and Classification Analysis, Linear Regression, Multiple Linear Regression, Logistic Regression, K-Nearest Neighbour (KNN), Naïve Bayes Classifier, Support Vector Machine (SVM), Decision Trees, Random Forest, Model Evaluation Techniques including Confusion Matrix, Accuracy, Precision, Recall, F1-Score, ROC-AUC Curve, MAE, MSE and RMSE	15 Hours	CO3
4	**Unsupervised Learning and Neural Networks:** Clustering Techniques, K-Means Clustering, Hierarchical Clustering, Density-Based Clustering (DBSCAN), Principal Component Analysis (PCA), Association Rule Mining and Apriori Algorithm, Introduction to Artificial Neural Networks, Perceptron Model, Backpropagation Algorithm, Real-world Applications of Machine Learning, Case Studies and Mini Project Development using Python	15 Hours	CO4

Suggested Readings

1. IBM, *IBM Courseware*, IBM Corp., 2015.
2. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, Sebastopol, CA, USA: O'Reilly Media, 2022,3rd Edition.
3. A. C. Müller and S. Guido, *Introduction to Machine Learning with Python: A Guide for Data Scientists*, Sebastopol, CA, USA: O'Reilly Media, 2016, 1st Edition.
4. E. Alpaydin, *Introduction to Machine Learning*, Cambridge, MA, USA: MIT Press, 2020,4th Edition.

Online Resources

1. Scikit-learn Documentation – Official documentation and tutorials for machine learning using Python
2. TensorFlow Tutorials – Official hands-on tutorials for building and training machine learning models.

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2	2	2		2		2	1	2	2	2
CO2	2	2	2	3	2	1	2		2	1	1	2	2
CO3	2	1	3	2	2		2		2	1		2	2
CO4	2		2		2	2	1		1		1	2	2

Program	B.Tech CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Design and Analysis of Algorithms				
Code	RCS5603				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Data Structure	3	1	0	4
Course Objectives	1.Analyse the asymptotic performance of algorithms. 2.Proving correctness of algorithms. 3. Demonstrate a familiarity with major algorithms and data structures. 4. Apply important algorithmic design paradigms and methods of analysis.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Analyse the problem and design an efficient algorithm to solve it by using & modifying classical design techniques or creating a new solution technique				
CO2	Evaluate and compare those using standard mathematical techniques and select the best solution				
CO3	Understand the mathematical criterion for deciding whether an algorithm is efficient, and know many practically important problems that do not admit any efficient algorithms.				
CO4	Apply the different kind of complexities and develop non deterministic solution to problems having large complexities.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction and Analysis of Algorithms:** Algorithm and its characteristics, Asymptotic Notations and Basic Efficiency Classes, Recurrence Relations, Solving Recurrence Relations using Master's Theorem, Time-Space Trade-off in algorithms. Analysis of Sorting Algorithms: Bubble Sort, Selection Sort and Insertion Sort **Advanced Data Structures:** Red-Black Trees, Binomial Heaps and Fibonacci Heaps.	15 Hours	CO1
2	**Divide and conquer approach:** Binary Search, Merge sort, Quick Sort, Strassen's Matrix Multiplication. **Greedy Methods:** Knapsack problem, Job sequencing with deadlines, Huffman Coding, Minimum Spanning Trees: Prim's and Kruskal's Algorithm.	15 Hours	CO2
3	**Dynamic Programming**: 0/1 Knapsack, All Pair Shortest Paths-Floyd's Warshal's Algorithms, Matrix chain multiplication, Longest common subsequence, Single Source Shortest Paths-Dijkstra's and Bellman Ford Algorithms. **Backtracking**: Graph Coloring, n-Queen Problem, Hamiltonian Cycles and Sum of Subsets.	15 Hours	CO3
4	**Branch and Bound:** Travelling Salesman Problem. **String Matching:** The naïve method, Rabin- Karp method, Boyer-Moore, Knuth-Morris-Pratta (KMP).	15 Hours	CO4

	Advanced topics: Theory of NP-Completeness, Approximation Algorithms and Randomized Algorithms.		

Suggested Readings

1. Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest, “Introduction to Algorithms”, Printice Hall of India.
2. E. Horowitz & S Sahni, "Fundamentals of Computer Algorithms".
3. Aho, Hopcraft, Ullman, “The Design and Analysis of Computer Algorithms” Pearson Education, 2008.
4. LEE "Design & Analysis of Algorithms (POD)”, McGraw Hill

Online Resources

1. https://nptel.ac.in/courses/106106131

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	3	3	1	3							1	3
CO2	1	1	1	2	3							1	3
CO3	2	2	1	2	2							2	2
CO4	1	2	1	3	1							1	2

Program	B. Tech. CSE(CCML)				
Year	III	**Semester**	VI		
Course Name	Machine Learning Lab				
Course Code	RCCML5651				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Python Programming Language.	0	0	2	1
Course Objectives	1. To provide hands-on experience in data collection, preprocessing, and transformation using Python-based tools and libraries. 2. To develop skills in data visualization and exploratory data analysis for extracting meaningful insights from datasets. 3. To enable students to implement supervised and unsupervised machine learning algorithms on real-world datasets. 4. To equip learners with the ability to evaluate machine learning models and develop practical data-driven solutions for real-world applications.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply Python libraries for data manipulation, preprocessing, and visualization.				
CO2	Implement and evaluate supervised machine learning algorithms on real-world datasets.				
CO3	Apply unsupervised learning techniques for clustering and dimensionality reduction.				
CO4	Design and develop machine learning solutions for practical applications using industry-standard tools.				

S. No.	List of Experiments	Mapped CO
1	Perform data acquisition, preprocessing, handling missing values, and feature scaling on a real-world dataset using Python libraries such as Pandas and NumPy.	CO1
2	Develop programs to visualise and analyse datasets using various plotting techniques, including scatter plots, histograms, box plots, and heat maps, using Matplotlib and Seaborn	CO1
3	Implement Linear Regression on a given dataset and evaluate the	CO2

	performance of the model using appropriate error metrics.	
4	Implement Logistic Regression for classification problems and analyse the prediction results using a confusion matrix and classification metrics.	CO2
5	Develop and evaluate a K-Nearest Neighbour classifier using a standard dataset and compare actual and predicted outputs.	CO2
6	Implement the Naïve Bayes classification algorithm on a real-world dataset and evaluate its performance using suitable evaluation measures.	CO3
7	Implement Support Vector Machine (SVM) algorithms for classification tasks and compare the results with other classification techniques.	CO3
8	Implement a Decision Tree classifiers on real world dataset and analyze feature importance, tree structure, and classification performance.	CO3
9	Implement Random Forest classifiers and analyze the improvement in prediction accuracy over individual decision trees.	CO4
10	Apply model evaluation techniques including Accuracy, Precision, Recall, F1-Score, ROC Curve, and Confusion Matrix for performance assessment of machine learning models.	CO4
11.	Implement the K-Means clustering algorithm on a real-world dataset and analyze the quality of clusters formed.	CO4
12.	Develop a mini machine learning project involving data preprocessing, model building, evaluation, and interpretation using a real-world dataset from domains such as healthcare, finance, education, or retail.	CO4

Suggested Readings

1. IBM, *IBM Courseware*, IBM Corp., 2015.
2. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, Sebastopol, CA, USA: O'Reilly Media, 2022,3rd Edition.
3. A. C. Müller and S. Guido, *Introduction to Machine Learning with Python: A Guide for Data Scientists*, Sebastopol, CA, USA: O'Reilly Media, 2016, 1st Edition.
4. E. Alpaydin, *Introduction to Machine Learning*, Cambridge, MA, USA: MIT Press, 2020,4th Edition.

Online Resources

1. Virtual Labs (Ministry of Education, Government of India)
   https://www.vlab.co.in
2. IIT Kharagpur Virtual Labs – Data Analytics and Machine Learning Experiments

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	1	1							2	3	
CO2	2	2	1	3							2	3	
CO3	2	2	1	3							2	2	3
CO4	2	2	1	3							2	2	3

Program	B. Tech CSE (CCML)				
Year	III	Semester	VI		
Course Name	Design and Analysis of Algorithms Lab				
Code	RCS5653				
Course Type	PCC	L	T	P	Credit
Pre-Requisite	Command on Programming Language	0	0	2	1
Course Objectives	1. Analyze the asymptotic performance of algorithms. 2. Write rigorous correctness proofs for algorithms. 3. Demonstrate a familiarity with major algorithms and data structures. 4. Apply important algorithmic design paradigms and methods of analysis.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Implement various search techniques				
CO2	Implement various sorting techniques.				
CO3	Implement backtracking strategy.				
CO4	Implement various greedy and dynamic programming techniques.				

S. No.	List of Experiments	Mapped CO
1	Program for Recursive Binary & Linear Search.	CO1
2	Implement Merge Sort.	CO2
3	Implement Quick Sort (Divide & Conquer).	CO2
4	Implement Heap Sort.	CO2
5	Implement Knapsack problem (Greedy ALGO.).	CO4
6	Implement Insertion Sort.	CO2
7	Implement Shortest path by Dijkstra Algorithm.	CO1
8	Implement 8- Queen problem (Back Tracking).	CO3
9	Implement Prim's Algorithms.	CO1
10	Implement Kruskal's Algorithm.	CO4

Online Resources

1. https://cse01-iiith.vlabs.ac.in/exp/sorting/
2. http://ebootathon.com/labs/beta/csit/DAA/exp1/simulation.html

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	3	1						1	2	3
CO2	3	2	3	1	1						1	2	3
CO3	1	3	2	2	1							1	
CO4	1	2	3	1	2						2	2	2

Program	B. Tech (CSE/CSE-AI/CSE-CCML/CSE-AIBC)				
Year	IV	Semester		VII	
Course Name	AI Ethics				
Course Code	RCS5703				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamental Knowledge of AI, ML Models and Data Science	2	0	0	2
Course Objectives	1. To introduce the ethical, social, legal, and governance issues arising from Artificial Intelligence technologies. 2. To develop understanding of fairness, transparency, accountability, privacy, and responsible AI principles. 3. To analyse the societal impact of AI on individuals, organizations, and communities. 4. To apply ethical frameworks and regulatory guidelines to real-world AI applications.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain fundamental concepts, ethical theories, and principles related to AI systems.				
CO2	Identify and evaluate ethical issues such as bias, discrimination, privacy violations, and accountability in AI applications.				
CO3	Analyze the societal, legal, and economic impacts of AI deployment through case studies.				
CO4	Apply ethical frameworks, governance principles, and regulatory guidelines to assess AI systems.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to AI Ethics**: Evolution of Artificial Intelligence, Need for AI Ethics, Ethical Foundations: Utilitarianism, Deontology, Virtue Ethics, Human-Cantered AI, AI Ethics Frameworks and Global Perspectives, Ethics vs. Morality, AI Lifecycle and Ethical Challenges, Human Rights and AI, UNESCO Recommendations on AI Ethics	10 Hours	CO1
2	**Fairness, Bias and Accountability in AI**: Sources of Bias in Data and Algorithms, Algorithmic Fairness, Explainability and Interpretability, Accountability and Responsibility, AI Auditing and Risk Assessment, Data Bias, Sampling Bias, Discrimination in AI Systems, Fairness Metrics, Explainable AI (XAI).	10 Hours	CO2

3	**Privacy, Security and Legal Issues**: Data Privacy and Protection, Consent and Data Ownership, AI Security Risks, Intellectual Property Rights and AI, Cyber security and AI, Emerging AI Regulations. Privacy-Preserving AI, Surveillance Technologies, Data Governance, GDPR Overview, AI Act and Regulatory Approaches. **Governance, Responsible AI:** AI Governance Frameworks, Ethical AI Development Lifecycle, Responsible Innovation, Sustainability and AI, Ethical Failures and Successes, AI Risk Management, AI Ethics Assessment Tools, Industry Best Practices	10 Hours	CO3, CO4

Suggested Readings

1. Mark Coeckelbergh, *AI Ethics*, The MIT Press, 1st Edition, 2020.
2. Melanie Mitchell, *Artificial Intelligence: A Guide for Thinking Humans*, Farrar, Straus and Giroux, 1st Edition, 2019.
3. Markus D. Dubber, Frank Pasquale, and Sunit Das (Eds.), *The Oxford Handbook of Ethics of AI*, Oxford University Press, 1st Edition, 2020.

Online Resources

1. https://swayam-plus.swayam2.ac.in/courses/course-details?id=P_INTEL_02

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2			1							2	2
CO2	2	3	1	2	1							3	2
CO3	2	3	2	2	1							3	3
CO4	2	2	2	3	2						1	2	3

Program	B. Tech. CSE (CCML)					
Year	IV	**Semester**	VII			
Course Name	Concepts of Deep Learning					
Course Code	RCCML5701					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Knowledge of Machine Learning	3	1	0	4	
Course Objectives	1. Provide a comprehensive overview of deep learning, its evolution, and applications across domains such as computer vision, NLP, and speech processing. 2. Build foundational knowledge of neural network architectures, optimization algorithms, and regularization techniques for effective model training. 3. Familiarize learners with advanced deep learning models, including CNNs, RNNs, GANs, reinforcement learning, and transformers for real-world problem solving. 4. Encourage ethical awareness in AI development, addressing issues of bias, fairness, privacy, and responsible deployment of generative and large language models.					
Course Outcomes: After successful completion of the course, the student will be able to:						
CO1	Demonstrate the ability to design, implement, and optimize neural networks using frameworks such as TensorFlow and PyTorch.					
CO2	Apply CNNs, RNNs, GANs, reinforcement learning, and transformer-based architectures to solve data-intensive problems in vision, text, and sequential decision-making.					
CO3	Assess deep learning models using appropriate evaluation metrics, optimization strategies, and regularization techniques to ensure robust performance.					
CO4	Critically analyze and apply ethical principles in AI systems, ensuring fairness, transparency, and accountability in real-world applications.					

Module	**Course Content**	**Contact Hours**	**Mapped CO**
1	**Neural Network Fundamentals and Optimization**: Overview and evolution of Deep Learning, Applications of Deep Learning in Computer Vision, NLP, and Speech Processing, Neural Networks: Perceptron, MLP, and ANN Architectures, Setting up Python environment (Anaconda, Jupyter, TensorFlow, PyTorch), Forward Propagation and Backpropagation Algorithms, Activation Functions: Sigmoid, Tanh, ReLU, Leaky	15 Hours	CO1

	ReLU, Loss Functions and Cost Optimization, Gradient Descent and Optimization Algorithms (SGD, Adam, RMSProp), Regularization Techniques: Dropout and Batch Normalization, Model Evaluation Metrics and Performance Analysis.		
2	**CNNs, RNNs and Sequence Modelling:** CNN Architecture and Components: convolution, pooling, padding, and feature maps, Image Classification using CNN with MNIST and CIFAR-10 datasets, Transfer Learning using pre-trained models such as VGG and ResNet, Fine-Tuning CNN Models and Data Augmentation Techniques, Recurrent Neural Networks (RNNs) for Sequential Data Processing, Vanishing Gradient Problem and Solutions using LSTM and GRU, Sentiment Analysis using LSTM Networks, Text Generation using Recurrent Neural Networks, Introduction to Attention Mechanisms and Sequence Modelling.	15 Hours	CO2
3	**GANs, Reinforcement Learning:** Training GANs and Applications in Synthetic Data Generation, Conditional GANs and Style Transfer Techniques, Fundamentals of Reinforcement Learning and Markov Decision Processes (MDPs), Q-Learning and Deep Q-Networks (DQN), Deep Reinforcement Learning for Sequential Decision Making, Implementing DQN for CartPole and Atari Game Environments, Applications of Generative and Reinforcement Learning in Real-World Problems	15 Hours	CO3
4	**Advanced Deep Learning topics**: Introduction to Transformers and Self-Attention Mechanisms, Foundation Models and Generative AI Concepts, Hugging Face Transformers for Text Classification and Generation, Large Language Models (LLMs): Overview and Applications, Prompt Engineering and Fine-Tuning Techniques, Capsule Networks: Architecture and Comparative Analysis, Ethics in AI: Bias, Fairness, Privacy, and Responsible AI	15 Hours	CO4

Suggested Readings:

1. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*, Cambridge, MA, USA: MIT Press, 2016, 1st Edition.
2. F. Chollet, *Deep Learning with Python*, Shelter Island, NY, USA: Manning Publications, 2021, 2nd Edition.
3. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, Sebastopol, CA, USA: O'Reilly Media, 2022, 3rd Edition.

Online Resources

1. Deep Learning - https://nptel.ac.in/courses/106106184
2. https://swayam.gov.in/explorer?searchText=deep+learning

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2	2	2	3						1	1	1
CO2	3	3	1	2	1						2	2	1
CO3	2	1	2	1	1						2	2	2
CO4	1	2	1	3	2						1	1	1

Program	B. Tech. CSE (CCML)					
Year	IV	**Semester**	VII			
Course Name	Deep Learning Lab					
Course Code	RCCML5751					
Course Type	PCC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic of Python Programming	0	0	2	1	
Course Objectives	1. To understand the fundamentals of deep learning and neural networks. 2. To develop and train deep learning models using modern frameworks. 3. To apply advanced deep learning architectures such as CNNs, RNNs, and LSTMs. 4. To design, optimize, and deploy deep learning models for real-world applications.					
Course Outcomes: After successful completion of the course, the student will be able to:						
CO1	Understand deep learning fundamentals and neural networks.					
CO2	Develop and train deep learning models.					
CO3	Apply concepts of CNNs, RNNs, and LSTMs.					
CO4	Design and optimize deep learning solutions.					

S. No.	List of Experiments	Mapped CO
1	Implement a **Single Layer Perceptron** from scratch and train it on logical datasets (AND, OR, XOR). Analyze convergence and learning behavior.	CO1
2	Build a **Multilayer Feed Forward Neural Network (ANN)** using Tensor Flow/Keras for handwritten digit recognition using the **MNIST dataset**. Evaluate using Accuracy, Precision, Recall and F1-score	CO1
3	Design and train a **Deep Neural Network (DNN)** for customer churn prediction or Titanic survival prediction. Compare performance with Logistic Regression.	CO2
5	Build a **Convolution Neural Network (CNN)** for image classification using the **CIFAR-10 dataset**. Visualize feature maps and evaluate model performance.	CO2
6	Develop an **LSTM-based Recurrent Neural Network** using the Airline Passenger dataset to perform time-series forecasting. Analyze prediction errors using RMSE and MAE.	CO3

7	Use a pre-trained model like **ResNet** or **VGG16** for image classification. Fine-tune the last layers and apply data augmentation to improve accuracy on a smaller dataset.	CO3
8	Build a **Transformer-based Sentiment Analysis Model (BERT)** on IMDB/Amazon Reviews dataset. Compare results with LSTM.	CO4
9	Implement a **Generative Adversarial Network (GAN)** to generate handwritten digits or human face images. Evaluate generated image quality.	CO4
10	**Project Title**: Financial News Sentiment-Based Stock Prediction - Develop a hybrid Deep Learning model that combines historical stock market data and financial news sentiment analysis using LSTM and BERT/FinBERT to predict future stock prices and generate buy/sell recommendations.	CO3, CO4

Suggested Readings:

1. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*, Cambridge, MA, USA: MIT Press, 2016, 1st Edition.
2. F. Chollet, *Deep Learning with Python*, Shelter Island, NY, USA: Manning Publications, 2021, 2nd Edition.
3. A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, Sebastopol, CA, USA: O'Reilly Media, 2022, 3rd Edition.

Online Resources:

1. https://vlab.spit.ac.in/ai/

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2	1	3	1							1	1
CO2	1	2	3	1	1							1	1
CO3	1	1	2	1	2							2	2
CO4	1	1	1	3	1							1	1

Program	B. Tech(CSE-AI)				
Year	IV	**Semester**	VIII		
Course Name	Cyber Security and Computer Forensics				
Code	RCS5801				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Computer Networks and Fundamentals of Information Security	3	1	0	4
Course Objectives	1. Understand the fundamental concepts, threats, vulnerabilities, and defence mechanisms in cyber security. 2. Apply security technologies and tools to protect computing systems, networks, and digital assets. 3. Analyse cyber incidents and perform digital forensic investigations using standard methodologies. 4. Develop skills in evidence collection, preservation, analysis, reporting, and ethical/legal aspects of cyber forensics.				
Course Outcomes: After successful completion of the course, the student will be able to:					
CO1	Explain cyber security principles, cyber threats, attacks, vulnerabilities, and security controls.				
CO2	Apply network, system, and application security mechanisms to secure digital infrastructures.				
CO3	Perform digital forensic investigation including evidence acquisition, preservation, analysis, and reporting.				
CO4	Evaluate legal, ethical, and professional issues associated with cybercrime investigation and cyber security management.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Cyber Security:** Introduction to Cyber Security, Cyber Space and Security Challenges, Information Security Concepts, CIA Triad, Threats, Vulnerabilities and Risks, Types of Cyber Attacks, Malware, Phishing, Social Engineering, Password Attacks, Denial of Service (DoS/DDoS), Security Policies and Standards, Risk Assessment and Risk Management.	15 Hours	CO1
2	**Network and System Security:** Network Security Fundamentals, Firewalls and Intrusion Detection Systems, Intrusion Prevention Systems,	15 Hours	CO2

	Virtual Private Networks (VPN) and Secure Communication, Authentication and Access Control, Cryptography Fundamentals, Symmetric Encryption, Asymmetric Encryption, Hash Functions, Digital Signatures, Wireless Security, Cloud Security Basics.		
3	**Digital Forensics:** Introduction to Digital Forensics, Digital Forensic Process, Evidence Identification and Preservation, Disk Forensics, File System Analysis, Data Recovery Techniques, Memory Forensics, Email and Browser Forensics, Mobile Device Forensics, Forensic Tools and Utilities.	15 Hours	CO3
4	**Cyber Crime Investigation and Legal Issues:** Cyber Crimes and Classification, Cyber Crime Investigation Process, Incident Response and Handling, Chain of Custody, Digital Evidence Management, Cyber Laws and Regulations, Information Technology (IT) Act and Legal Framework, Ethical Issues in Cyber Security, Professional Responsibilities, Emerging Trends in Cyber Security and Digital Forensics.	15 Hours	CO4

Suggested Readings

1. DeFranco, Joanna F., and Bob Maley. What every engineer should know about cyber security and digital forensics. CRC Press, 2022.
2. Nelson Phillips and EnfingerSteuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi, 2009.
3. Ghonge, Mangesh M., et al., eds. Cyber security and digital forensics: Challenges and future trends. John Wiley & Sons, 2022.

Online Resources

1. https://onlinecourses.swayam2.ac.in/cec20_lb06
2. https://nptel.ac.in/courses/106106178

Course Articulation Matrix

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	1	3	1
CO2	3	3	2	1	3	-	-	-	-	-	1	3	3
CO3	2	3	2	3	3	-	-	1	1	-	1	2	3
CO4	1	2	-	1	-	2	3	1	2	1	1	1	2

Program	B.Tech CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Deployment of Private Cloud				
Code	RPEC53811				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of computer network.	3	0	0	3
Course Objectives	1. To understand Cloud concepts, introduction to IBM cloud Compare the advantages and disadvantages of various cloud computing platforms. 2. To learn introductory concepts of trade-offs between deploying applications in the cloud and over the local infrastructure. 3. This course will provide an overview regarding the performance, scalability, and availability of the underlying cloud technologies and software. 4. Learners will be able to understand how to work on containerization concept using Docker as a Tool and will work on Kubernetes.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the cloud concepts.				
CO2	To understand the implementation of cloud computing Science.				
CO3	To evaluate the application of cloud deployment with its phases.				
CO4	Applying and analyzing architecture with data management over cloud platforms.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Open Shift** Introduction to OpenShift, three kinds of Platform, advantages of using OpenShift, OpenShift architecture, OpenShift components, benefits of OpenShift, **Core Concepts** Understand containers and images, pods and services, Builds and streams, Routes & Templates, Deployments, Storage concepts, OpenShift networking concepts **Installation of OpenShift platform** The servers for installation, Steps to install and configure an OpenShift cluster, post-installation step.	30 Hours	CO1
2	**Configuration of OpenShift platform** change log in identity provider, Create and manage users and accounts, Deploy an OpenShift router, Deploy an internal registry **Use of web interface** Fork a sample repository, create projects and applications, Verify if the application us running, Configuring automated builds, code change and manually rebuild image. **Use of command line interface** Create projects and applications, verify if the application us running, configuring automated builds, code change and manually rebuild images	30 Hours	CO2, CO3

3	**Creating custom container images** Custom docker image creation approaches (Understand basics of a docker file, Design considerations for a custom docker file, building custom images using a docker file) **Controlling access to OpenShift resources** access control on OpenShift resources, secrets and their application, security policies and their application **Allocation persistent storage** Understand persistent storage concepts such as PVs and PVCs, Implement persistent storage for use by the application, persistence is configured for internal registry **Managing application deployments** manage the applications deployed on OpenShift (Understand pod replicas and how to scale them, control pod scheduling, Manage image, image streams, templates)	30 Hours	CO3, CO4

Suggested Readings

1. Ajay Kumar, "Microsevices Architecture", Self published, 2018, 1st Edition.
2. Sam Newman, "Building Microservices", O'Reilly Media Inc, 2014, 1st Edition.

Online Resource

1. https://archive.nptel.ac.in/courses/106/105/106105223/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1								1	2	1
CO2	2	1	2	2								2	2	1
CO3	2	2	1	2								2	2	1
CO4	2	2	2	2								2	2	2

Program	B.Tech. CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Cloud Native				
Code	RPEC53812				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Knowledge of Hybrid Cloud	2	1	0	3
Course Objectives	1. Describe the characteristics of cloud-native applications. 2. Understand hybrid cloud concepts and benefits. 3. Explain application modernization with hybrid cloud. 4. The course will explain the concepts and use of container technology andcontainerized applications.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the vision of Cloud native application development from a global context.				
CO2	Analyzing RedHat OpenShift architecture and APIs with application development.				
CO3	To evaluate the application of DevOps with Red hat Open Shift architecture in Industrial Automation.				
CO4	Applying research activities based on application development with Red hat Open Shift.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Hybrid Clouds** Definition of Cloud native applications, understand concepts of hybrid cloud and its connectivity, Understand application modernization with hybrid cloud, Concept of security architecture in hybrid cloud, Definition of Multi-Cloud **Foundations of Cloud Native Application Development** Understand twelve-factor app methodology, Linux containers, Introduction to Micro services architecture and its integration Architecture of IBM Kubernetes Service, Virtual machines and Containers isolation, Rapid security patching by using container image layering, DevOps. **Architecture overview of IBM Kubernetes Service (IKS)** Technical architecture of Kubernetes Container Platform, Pods, Role of master nodes, and worker nodes, Role of scheduler, Services and Routes with working, Persistent storage and listits benefits with Kubernetes, external routing into Kubernetes applications and the router‘s role, Internal routing within Kubernetes, Workflow of a pod deployment in Kubernetes.	15 Hours	CO1, CO2
2	**Introduction to Red Hat OpenShift on IBM Cloud** Introduction Red Hat OpenShift on IBM Cloud architecture, Keyfeatures of Red Hat OpenShift, Understand namespaces, users,and resource quota limits, application creation and auto scaling processes.	15 Hours	CO2, CO3

	Configuring applications on Red Hat OpenShift Understand application configuration concepts, Role of volumes in cloud native application development, Concept of persistent volumes, what are environment variables, Concept of secrets, what are Configure Map, Articulate downward API, **DevOps for Red Hat OpenShift applications on IBM Cloud** Challenges of application integration, features of continuous integration (CI) and its best practices, Understand workflows, their benefits, and their tools, Introduction to DevOps Practices, Continues Delivery, Understand deployment pipeline process, Explain DevSecOps and why it is important, Understand toolchains on IBM Cloud		
3	**Continuous integration/continuous deployment (CI/CD) and pipelines with OpenShift** Understand the concepts of DevOps and CI/CD, Process of application deployment, Role of deployment configurations, Red Hat OpenShift on IBM Cloud deployment options, Red Hat OpenShift on IBM Cloud deployment options, Scaling application and trigger new deployment, Understand CI/CD workflow and how it is implemented with Red Hat OpenShift on IBM Cloud, benefits of CI/CD and its best practices, Concept of a delivery pipeline, concept of an image stream. **Bringing it all together on Red Hat OpenShift** Review logs and events by using Red Hat OpenShift built-in logging and monitoring, understand metric dashboards by using Red Hat OpenShift built-in metrics dashboards, Integration of application with Cloud ant, Integrate the Red Hat OpenShift cluster with the IBM Cloud Log Analysis service. **Projects** Research Activities with Cloud native application development	15 Hours	CO4

Suggested Readings

1. G. Dumpleton, *Deploying to OpenShift: A Guide for Busy Developers*, 1st editions. Sebastopol, CA, USA: O'Reilly Media, 2017.
2. C. Davis, *Cloud Native Patterns: Designing Change-Tolerant Software*, 1st edition. Shelter Island, NY, USA: Manning Publications, 2019.
3. M. Hausenblas and S. Schimanski, *Programming Kubernetes: Developing Cloud-Native Applications*, 1st edition. Sebastopol, CA, USA: O'Reilly Media, 2020.

Online Resources

1. Cloud Native Applications Architecture Design Best Practices | Udemy.

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2			2						1	3	2
CO2	2	2			3						1	2	2
CO3	2	2	3								1	3	2
CO4	2	2	2		2						1	3	2

Program	B. Tech. CSE(CCML)				
Year	III	**Semester**	VI		
Course Name	Evolutionary Algorithms				
Code	RPEC53813				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Mathematics	2	1	0	3
Course Objectives	1. How to solve hard problems without using complex mathematical formulations 2. Design algorithms that are robust yet easy to program 3. To solve optimization related problems efficiently. 4. To learn to formulate a given problem as an optimization problem and apply EAs				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand a given problem amenable for evolutionary optimization/search				
CO2	Apply appropriate evolutionary algorithms for a given problem				
CO3	Analyze the state-of-the-art evolutionary computation research literature				
CO4	Evaluate suitable evolutionary algorithms for a real-world application				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Introduction to Evolutionary Computation, Biological Background: Principles of Darwinian natural selection, Historical Development of EC, Genetic Algorithms, Genetic Programming, Evolutionary Strategies and Evolutionary Programming, Features of Evolutionary Computation, Advantages of Evolutionary Computation Applications of Evolutionary Computation.	15 Hours	CO1
2	**Genetic Algorithms:** Overview of Conventional Optimization and Search Techniques, Simple Genetic Algorithm, terminology: Individual, Genes, Fitness, Population, Encoding, Breeding, Termination, Comparison with Other Optimization, Techniques GA in search, optimization, and machine learning. Case Study of Travelling Salesman Problem	15 Hours	CO2
3	**Evolutionary Strategies:** Introduction, Comparison with GA & GP Operators: Gaussian Mutation Operator and Intermediate Recombination Operator. Application of ES for Image Enhancement, Foundations of Evolutionary Algorithms, Schemas and the two-armed bandit problem, Advantages and disadvantages of evolutionary algorithms over alternative methods. Co-evolutionary Algorithms: Cooperative co-evolution, Competitive co-evolution, Swarm intelligence and ant colony optimization.	15 Hours	CO3, CO4

Suggested Readings

1. S. Sivanandam and S. N. Deepa, *Introduction to Genetic Algorithms*, 1st edition. Berlin, Germany: Springer, 2008.
2. M. Mitchell, *An Introduction to Genetic Algorithms*, 1st edition. New Delhi, India: Prentice Hall of India, 1996.
3. D. E. Goldberg, *Genetic Algorithms in Search, Optimization, and Machine Learning*, 1st edition. Reading, MA, USA: Addison-Wesley, 1989.
4. Z. Michalewicz, *Genetic Algorithms + Data Structures = Evolution Programs*, 3rd edition. Berlin, Germany: Springer-Verlag, 1997.
5. D. E. Goldberg, *Genetic Algorithms*, 1st edition. New Delhi, India: Pearson Education, 2006.
6. T. Bäck, D. B. Fogel, and Z. Michalewicz, *Evolutionary Computation 1: Basic Algorithms and Operators*, 1st edition. Berlin, Germany: Institute of Physics Publishing, 2000.

Online Resources

1. https://www.youtube.com/@npteliitguwahati8283

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1		1	1							1	1
CO2	1	2	1	2	1							1	2
CO3	2	1		2								2	2
CO4	2	2	1	1	1							1	1

Program	B. Tech. CSE (CCML)				
Year	III	Semester	VI		
Course Name	Internet of Things				
Course Code	RPEC53814				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of AI and Computer	2	1	0	3
Course Objectives	1. Describe IoT architecture, communication protocols, and functional components. 2. Understand embedded IoT platforms (Arduino, Raspberry Pi) at an architectural and conceptual level. 3. Evaluate SDN-based networking, security, privacy, and scalability challenges in IoT deployments. 4. Apply IoT to robotics, cyber-physical systems, and emerging domains.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand IoT concepts, functional blocks, communication models, and reference architectures.				
CO2	Describe the architecture of embedded IoT platforms (Arduino, Raspberry Pi) and their role in IoT systems.				
CO3	Analyze IoT applications, SDN integration, security threats, and scalability constraints.				
CO4	Apply IoT in robotics and cyber-physical systems; assess future trends including AIoT and digital twins.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to IoT:** IoT definition, characteristics, and functional blocks, Sensing and actuation principles; physical and logical design of IoT, Communication models and APIs; protocols: MQTT, CoAP, HTTP and selection criteria, Sensor networks and M2M vs IoT value chains. **IoT Architecture & Reference Models:** Reference Architecture and Reference Model of IoT, Four architectural views: Functional, Information, Operational, Deployment, Technical design constraints. **Embedded Platforms for IoT:** Arduino-microcontroller architecture (CPU, GPIO, ADC, PWM), communication interfaces (UART, I2C, SPI), sketch structure, role as IoT edge node, Raspberry Pi.	15 Hours	CO1, CO2
2	**SDN, Applications, Security & Constraints:** Control plane vs data plane separation; OpenFlow basics, SDN controllers (Open Daylight, ONOS); dynamic traffic control and QoS, NFV and IoT edge networks; SDN for heterogeneous device scalability. **Domain-Specific Applications**: Home automation, Industry 4.0 and IIoT, surveillance, Case Study.,	15 Hours	CO2, CO3

	Healthcare IoT (wearables, remote patient monitoring), smart agriculture, smart cities, Cloud platforms (AWS IoT Core, Azure IoT Hub) as deployment context. **Constraints, Security & Privacy**: Resource constraints - power, memory, compute on edge devices; interoperability and scalability, Threat landscape-device hijacking, botnets (Mirai), eavesdropping.		
3	**IoT in Robotics, CPS &Future Trends:** Networked actuators, sensor fusion, and remote teleoperation, ROS and IoT integration; collaborative robots (robots) and Autonomous Mobile Robots (AMRs).**,** Predictive maintenance via IoT sensors; cloud robotics; swarm robotics. **Cyber-Physical Systems (CPS):** CPS architecture and integration of computation with physical processes, CPS vs IoT distinction; real-time control loops, Safety-critical CPS-autonomous vehicles, industrial control systems. **Future Trends in IoT**: An IoT - AI and IoT convergence for edge intelligence, Digital Twins-virtual replicas of physical IoT systems, Green IoT-energy harvesting, sustainable design, Standardization overview-Matter protocol, oneM2M, W3C WoT.	15 Hours	CO3, CO4

Suggested Readings

1. Vijay Madisetti & Arsh deep Bahga, "Internet of Things: A Hands-on Approach", 1st Edition, 2014
2. Francis da Costa, "Rethinking the Internet of Things", Apress Publications, 2013
3. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011
4. Simon Monk, "Programming the Raspberry Pi", McGraw-Hill, 2nd Edition.
5. Raj Rajkumar et al., "Cyber-Physical Systems: The Next Computing Revolution",

Online Resources

1. https://onlinecourses.nptel.ac.in/noc22_cs53 — NPTEL IoT (IIT KGP)
2. https://www.coursera.org/specializations/iot — IoT Specialization (UC San Diego)
3. https://www.arduino.cc/en/Guide — Arduino Official Documentation

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	1		1							2	1
CO2	3	2	1	2	2							1	2
CO3		3	2	1	2							2	1
CO4	1		2	1	1							2	1

Program	B. Tech. CSE (CCML)				
Year	III	Semester		VI	
Course Name	Network Security and Cryptography				
Code	RPEC53821				
Course Type	PEC	L	T	P	Credit
Pre-Requisite	Security Services and Mechanism	2	1	0	3
Course Objectives	1. Have a fundamental understanding of the objectives of cryptography and network security. 2. Getting familiar with the cryptographic techniques that provide information and network security. 3. To know the different types of algorithms for exchanging information in a secret way. 4. To know the possible threats which can break the secure communication.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understanding cryptography and network security concepts and applications.				
CO2	Apply security principals to system design and real-time scenarios.				
CO3	To evaluate the application of security with Digital Signature.				
CO4	Analysis of network traffic and security threats.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Cryptography and Symmetric Ciphers** Security Attacks: Security Services and mechanism; Classical encryption techniques: Substitution ciphers and Transposition ciphers, Steganography, Cryptanalysis; Modern Block Ciphers: Stream and Block Cipher, Block Cipher Principles, Block Cipher Modes of Operations; Shannon's theory of Confusion and Diffusion; Feistel structure; Data Encryption Standard (DES); Strength of DES; Idea of differential cryptanalysis; Triple DES; Symmetric Key Distribution; Finite Fields: Introduction to groups, rings and fields, Modular Arithmetic, Euclidean Algorithm, Finite Fields of the form GF(p).	15 Hours	CO1
2	**Basics of Number Theory and Public Key Cryptography** **Introduction to Number Theory:** Prime and Relative Prime Numbers, Fermat's and Euler's theorem, Testing for Primality, Chinese Remainder Theorem, Discrete Logarithms. **Public Key Cryptography:** Principles of Public-Key Cryptography, RSA Algorithm, Security of RSA, Key Management, Diffie-Hellman Key Exchange, Elliptic curve cryptography	15 Hours	CO2

3	**Hash Functions and Digital Signatures:** Message Authentication; Hash Functions; Secure Hash Functions; Security of Hash Functions and MACs; Digital Signatures; Digital Signature Standards (DSS); Proof of Digital Signature Algorithm; Advanced Encryption Standard (AES) encryption and decryption. **Network and System Security:** Authentication Applications: Kerberos, X.509 Certificates; Electronic Mail Security: Pretty Good Privacy (PGP), S/MIME; IP Security: IP security overview, IP security policy, Encapsulating Security Payload (ESP), Combining Security Associations; Web Security: Secure Socket Layer (SSL) and Transport Layer Security (TLS), Secure Electronic Transaction (SET); Intruders; Viruses; Firewalls.	15 Hours	CO3, CO 4

Suggested Readings

1. W. Stallings, *Cryptography and Network Security: Principles and Practice*, 7th editions. New Delhi, India: Pearson Education, 2017.
2. B. A. Forouzan, *Cryptography and Network Security*, 1st edition. New Delhi, India: Tata McGraw-Hill, 2008.
3. B. Schneier, *Applied Cryptography: Protocols, Algorithms, and Source Code in C*, 2nd edition. Hoboken, NJ, USA: John Wiley & Sons, 1996.

Online Resources

1. http://swayam.gov.in/
2. https://nptel.ac.in/

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO12**	**PSO1**	**PSO2**
CO1	2	2									1		
CO2	2	2									1	2	
CO3	2	2	3								1	3	2
CO4	2	2	2		2						1	3	2

Program	B.Tech. CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Cloud Security				
Code	RPEC53822				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basics of Cloud Computing	2	1	0	3
Course Objectives	1. Understand the vision of Cloud and its security. 2. To understand the implementation of Forensic Science. 3. Applying and analyzing architecture with data management over cloud platforms. 4. To evaluate the application of cloud security with its phases.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	To understand Cloud concepts, introduction to IBM cloud, ISO 27017-Cloud Security, PCI DSS Controls, Flips Levels.				
CO2	To analyze concepts of Cloud Data Life Cycle (CSUSAD).				
CO3	Evaluate an overview regarding Management plan implementation & Cloud Forensics.				
CO4	Apply how to work on containerization concept using Docker as a Tool and will work on Kubernetes.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Security in cloud model** Cloud Security Model, Cloud Broker Services, Introduction to IBM Cloud, Network Perimeter, what is Encryption, Cloud Foundry, Cryptographic Erasure, ISO 27017-Cloud Security 11114, NIST DP 800-53, PCI DSS Controls, FIPS Levels. **Enterprise Cloud management** Management plan implementation, what is Forensic Science, Evidence Management, OECD Privacy Principles, eDiscovery, GDPR's Key Points, Gap Analysis, ISO 27001: 2013 Domains, Risk Terminology, The CSA STAR components, Supply Chain Risk.	15 Hours	CO1, CO2
2	**Cloud Data Life Cycle (CSUSAD) & DLP (data Loss Prevention** Key data function: Access Process and Store, Data functions mapping to the data life cycle, Controls, Data dispersion in cloud storage, Erasure Coding, Threat to storage types, Database encryption, Gateway encryption, Key storage in cloud Containerization Data De-identification/anonymization, Tokenization, DLP (data Loss Prevention), Data Discovery, DRM (digital rights management), Crypto-shredding, Chain of Custody, Software-Defined Networking (SDN), Data center design standards, ENISA, Data protection risk, Risk assessment/Analysis, Automation of Controls, iSCSI.	15 Hours	CO3

3	**Audit Mechanism & Application Security** Key regulations for CSP facilities ,IAM ,VPC, Understanding of Cloud environment, BCDR planning factors, Business impact analysis (BIA), Design phase, API types, Phases and Methodologies, Cross-site scripting, Security misconfiguration , Threat Modelling, Software Supply-chain (API) management, ISO/IEC 27034-1IAM on Cloud Federated Identity management, SAML,WS federation, OAuth2.0, OpenID Connect, Reduced Sign-on (RSO), Database activity Monitor, Application, Virtualization, Cloud Secure Development Life Cycle, Open Web Application Security Project (OWASP), VLANs, Distributed Resource Scheduling (DRS), Patch Management, Performance Monitoring, Intrusion Detection System	15 Hours	CO4

Suggested Readings

1. R. L. Krutz and R. D. Vines, *Cloud Security: A Comprehensive Guide to Secure Cloud Computing*, 1st editions. Hoboken, NJ, USA: Wiley, 2010.
2. J. R. Vacca, *Cloud Computing Security: Foundations and Challenges*, 1st edition. Boca Raton, FL, USA: CRC Press, 2014.
3. E. Castro-Leon and R. Yeluri, *Building the Infrastructure for Cloud Security: A Solutions View*, 1st edition. New York, NY, USA: Springer, 2016.
4. T. Radichel, *Cybersecurity for Executives in the Age of Cloud*, 1st edition. New York, NY, USA: Apress, 2017.

Online Resources

1. https://www.youtube.com/@cloudcomputing351
2. https://www.youtube.com/@MrKeerthikiran

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1			1	2							2	1
CO2		2	1		2							2	
CO3	2	1	2										3
CO4		2	1		2						2	1	2

Program	B.Tech. CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Robotics				
Code	RPEC53823				
Course Type	PEC	L	T	P	Credit
Pre-Requisite	Basic Knowledge of Robot.	2	1	0	3
Course Objectives	1. This course introduces the mechanics of robots and spatial mechanics and motion planning. 2. The theoretical focus is on kinematics and dynamics of robotic manipulators and control design for non-linear mechanical systems. 3. Laboratory practice to learn simple robot programming. 4. This course will also expose students to some of the contemporary happenings in robotics, including current robotics research, applications, robot contests and robot web surfing.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand basic mathematic manipulations of spatial coordinate representation and transformation.				
CO2	Analyze history, concept development and key components of robotics technologies.				
CO3	Evaluate basic robot forward and inverse kinematics problems.				
CO4	Apply basic robotic dynamics, path planning and control problems.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Definition, Classification of Robots, geometric classification and control classification. Robot Elements: Drive system, control system, sensors, end effectors, gripper actuators and gripper design.	15 Hours	CO1
2	**Robot Coordinate Systems and Manipulator Kinematics:** Robot co-ordinate system representation, transformation, homogenous transform and its inverse, relating the robot to its world. Manipulators Kinematics, parameters of links and joints, kinematic chains, dynamics of kinematic chains, trajectory planning and control, advanced techniques of kinematics and dynamics of mechanical systems, parallel actuated and closed loop manipulators.	15 Hours	CO2
3	**Robot Control:** Fundamental principles, classification, position, path velocity and force control systems, computed torque control, adaptive control, Seroo system for robot control, and introduction to robot vision, Robot Programming: Level of robot programming, language-based programming, task level programming, robot programming synthesis, robot programming for welding, machine tools, material handling, assembly operations, collision free motion planning.	15 Hours	CO3, CO4

	Applications: Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.		

Suggested Readings

1. C. Chirroza, *An Introduction to Robot Technology*, 1st edition. London, UK: Kogan Page, 1985.
2. Y. Koren, *Robotics for Engineers*, 1st edition. New York, NY, USA: McGraw-Hill, 1985.
3. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, *Robotics: Control, Sensing, Vision, and Intelligence*, 1st edition. New York, NY, USA: McGraw-Hill, 1987.
4. J. J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd edition. Reading, MA, USA: Addison-Wesley, 2005.
5. R. Grover, M. Weiss, N. Nagel, and O. Octrey, *Industrial Robots: Technology, Programming, and Applications*, 1st edition. New York, NY, USA: McGraw-Hill, 1986.
6. C. Asfahl, *Robots and Manufacturing Automation*, 2nd edition. New Delhi, India: Wiley Eastern, 1992.

Online Resources

1. https://www.youtube.com/@nptel-nociitm9240
2. https://www.youtube.com/@IITKharagpurJuly-is9ie

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2		1	2								3	3
CO2	2	2		2								3	
CO3	2	2	2									1	2
CO4	3	2	3	1								2	2

Program	B. Tech CSE (CCML)				
Year	III	**Semester**	VI		
Course Name	Fuzzy Logic				
Code	RPEC53824				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamentals of AI	2	1	0	3
Course Objectives	1. To teach about the concept of fuzziness involved in various systems. To provide adequate knowledge about fuzzy set theory. 2. To provide adequate knowledge of application of fuzzy logic control to real time systems. 3. Comprehend the fuzzy logic control and to design the fuzzy control using genetic algorithms. 4. Apply basic fuzzy system modelling methods.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand fuzzy logic membership function.				
CO2	Analyse on Fuzzy logic membership function and fuzzy inference systems.				
CO3	Design the fuzzy set theory on the statistical method which is given.				
CO4	Analyse statistical data by using fuzzy logic methods.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction, Classical Sets and Fuzzy Sets:** Classical sets: Operations and properties of classical sets, Mapping of classical sets to the functions. Fuzzy sets - Membership functions, Fuzzy set operations, Properties of fuzzy sets. Classical and Fuzzy relations: Cartesian product, crisp relations-cardinality, operations, and properties of crisp relations. Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition, Fuzzy tolerance and equivalence relations, value assignments and other format of the composition operation.	15 Hours	CO1
2	**Fuzzification and Defuzzification:** Features of the membership functions, various forms, fuzzification, defuzzification to crisp sets, - cuts for fuzzy relations, Defuzzification to scalars. Fuzzy logic and approximate reasoning, other forms of the implication operation. **Fuzzy Systems:** Natural language, Linguistic hedges, Fuzzy (Rule based) System, Aggregation of fuzzy rules, Graphical techniques of inference, Membership value assignments: Intuition, Inference, rank ordering, Fuzzy Associative memories.	15 Hours	CO2, CO3
3	**Fuzzy decision making:** Fuzzy synthetic evaluation, Fuzzy ordering, Preference and consensus, Multi objective decision making, Fuzzy Bayesian, Decision method, Decision making under Fuzzy states and fuzzy actions.	15 Hours	CO3

	Fuzzy Classification: Classification by equivalence relations-crisp relations, Fuzzy relations, Cluster analysis, Cluster validity, C-Means clustering, Hard C-Means clustering, Fuzzy C-Means algorithm, Classification metric, Hardening the Fuzzy C-Partition.		

Suggested Readings

1. Timothy J. Ross - Fuzzy logic with engineering applications, 3rd edition, Wiley, 2010.
2. George J. KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, 1st edition.New Delhi, 1995.

Online Resources

1. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=111106048

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	3	1		3							1	
CO2	1	2	2	1								1	1
CO3	2	1	3	1	2							1	
CO4	1	2	1		3							1	

Program	B. Tech CSE (CCML)				
Year	IV	**Semester**	VII		
Course Name	Artificial Neural Network				
Code	RPEC53831				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Probability and statistics	2	1	0	3
Course Objectives	1. Introduction of biological neuron and artificial neuron for solving problems 2. To understand basis neural networks models 3. To understand the application areas of neural networks 4. To apply ANN for solving problems.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Introduction to basic working of neuron working and learning.				
CO2	To understand Perceptron learning techniques and application.				
CO3	To understand and apply back propagation for ANN learning.				
CO4	To understand the basics of supervised learning.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Human Brain, Neural Network, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks, Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process.	15 Hours	CO1
2	**Perceptron:** Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection.	15 Hours	CO2
3	**Back Propagation:** Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues, and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning	15 Hours	CO3, CO4

Suggested Readings

1. S. Haykin, *Neural Networks: A Comprehensive Foundation*, 2nd editions. New Delhi, India: Prentice-Hall of India (PHI), 2004.
2. B. Yegnanarayana, *Artificial Neural Networks*, 1st edition. New Delhi, India: Prentice-Hall of India Pvt. Ltd., 2005.

3. L. M. Fu, *Neural Networks in Computer Intelligence*, 1st edition. New Delhi, India: Tata McGraw-Hill, 2003.

Online Resources

1. https://nptel.ac.in/courses/117105084

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	3	2								2	1
CO2	3	2	2	2								2	2
CO3	3	1	2	1								1	2
CO4	3	2	3	3								3	3

Program	B. Tech CSE				
Year	IV	**Semester**	VII		
Course Name	Computer Vision				
Code	RPEC53832				
Course Type	PCC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Machine Learning, Computer Graphics	2	1	0	3
Course Objectives	1. To acquire knowledge of image processing concepts. 2. To apply filtering and edge detection techniques. 3.To apply deep learning for recognition and feature detection in images and videos. 4. To understand image enhancement and transformation techniques.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understanding basics of Image Processing and Photometric.				
CO2	Understanding Image Filtering and edge detection.				
CO3	Understanding application of deep learning in image processing and recognition.				
CO4	Understanding feature detection and motion.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to image processing & Image formation:** Geometric primitives and transformations, Photometric image formation, digital camera **Image processing:** Point operators, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Model fitting and optimization, Variational methods and regularization, Markov random fields	15 Hours	CO1
2	**Linear Filtering:** Filter Kernels, Linear Filter Experiments, Linear Convolution Filtering, Selecting a Region-of-Interest, Adding Noise to Image, Mean Filtering, Median Filtering, Rank Order Filtering, Normal Distribution Filtering, Edges, Lines, Corners, Gaussian Kernel and Voronoi Meshes, Linear Function, Edge Detection, Double Precision Laplacian	15 Hours	CO2

	Filter, Enhancing Digital Image Edges, Gaussian Kernel, Gaussian Filter, Image Gradient Approach to Isolating Image Edges		
3	**Deep Learning:** Supervised learning, Unsupervised learning, Deep neural networks, Convolutional neural networks, More complex models **Recognition:** Instance recognition, Image classification, Object detection, Semantic segmentation, Pose estimation, Video understanding, Vision and language **Feature detection and matching:** Edges and contours, Contour tracking, Lines and vanishing points, Segmentation **Motion estimation:** Translational alignment, Parametric motion, Optical flow, Layered motion Computational photography, High dynamic range imaging, Super-resolution, denoising, and blur removal, Image matting and compositing, Video matting, Texture analysis and synthesis	15 Hours	CO3, CO4

Suggested Readings

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", 2nd Edition, September 30, 2022 Springer
2. James F James F. Peters, "Foundations of Computer Vision, Computational Geometry, Visual Image, Structures and Object Shape Detection", 124, Springer
3. E. R. Davies, "Computer and Machine Vision: Theory, Algorithms, Practicalities", 4th Edition, 2012, Elsevier
4. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck,"MACHINE VISION", McGraw-Hill, Inc., ISBN 0-07-032018-7, 1995

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	3	3	2						2	3	3
CO2	3	3	3	3	3						2	2	3
CO3	3	3	3	3	3						2	3	3
CO4	3	3	3	3	2						2	3	3

Program	B Tech CSE(CCML)				
Year	IV	**Semester**	VII		
Course Name	Data Visualization and Statistics				
Code	RPEC53833				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Python Programming	2	1	0	3
Course Objectives	1. To learn different statistical methods for Data visualization 2. To learn basics of Watson Studio R and Python. 3. To learn about packages Numpy, pandas and matplotlib 4. To learn the functionalities and usages of Seaborn.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	To understand the visualization pipeline with its relationship to other data analysis pipelines.				
CO2	Implement and evaluate data to IU-supported research storage for both short- and long-term preservation in order to comply with data management mandates.				
CO3	To acquire and apply data visualization tools on various data sets.				
CO4	To properly document and organize data and visualizations in order to prepare them for reuse.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction of Statistics:** Introduction to Statistics, Difference between inferential statistics and descriptive statistics, Inferential Statistics-Drawing Inferences from Data, Random Variables, Normal Probability Distribution, Sampling, Sample Statistics and Sampling Distributions. R overview and Installation-Overview and About R, R and R studio Installation, Descriptive Data analysis using R, Description of basic functions used to describe data in R..	15 Hours	CO1
2	**Data Visualization with Watson Studio:** Introduction to data visualization, Adding data to data refinery, Visualization of Data on Watson Studio, Data manipulation packages, Data visualization with R.	15 Hours	CO2
3	**Data Visualization with Python:** Introduction to Python, installation, Introduction to Jupyter Notebook, Python scripting basics, Numpy and Pandas, Matplotlib overview, Basic plots using matplotlib, Specialized Visualization Tools	15 Hours	CO3, CO4

	using Matplotlib, Advanced Visualization Tools using MatplotlibWaffle Charts, Word Clouds. **Seaborn Overview:** Introduction to seaborn, Seaborn functionalities and usage, Spatial Visualizations and Analysis in Python with Folium, Distribution, Categorical Plots, Matrix Plots, Regression Plots, Choropleth Maps, Grids, Style and Colors, Case Study.		

Suggested Readings

1. IBM, *IBM Courseware*, IBM Corp., 2015.
2. A. Kassambara, *R Graphics Essentials for Great Data Visualization*, 1st edition. North Carolina, USA: STHDA Publishing, 2017.
3. R. N. Rao, *Core Python Programming*, 2nd edition. New Delhi, India: Dreamtech Press, 2018.
4. E. R. Tufte, *The Visual Display of Quantitative Information*, 2nd edition. Cheshire, CT, USA: Graphics Press, 2001.
5. E. R. Tufte, *Envisioning Information*, 1st edition. Cheshire, CT, USA: Graphics Press, 1990.

Online Resources

1 https://www.youtube.com/@IITMadrasBSDegreeProgramme

2. https://www.youtube.com/@nptel-nociitm9240

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	3		3	1						1	2	1
CO2		2		3	1						1	2	1
CO3		2		2							1	2	1
CO4		2	1	1	1						1	2	1

Program	B.Tech. CSE (CCML)					
Year	IV	**Semester**	VII			
Course Name	No SQL and MongoDB					
Course Code	RPEC 53834					
Course Type	PEC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic of Database	2	1	0	3	
Course Objectives	1. Understand and critically apply the concepts and methods of Business analytics.					
	2. To understand and apply IBM SPSS Modeler in Data Mining, what kinds of data can be mined, what kinds of patterns can be mined.					
	3. Applying and analyzing how to use functions, deal with missing values, use advanced field operations, handle sequence data and improve efficiency.					
	4. To evaluate the Model on the basis of different Predictive Methods.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	To understand an overview of an exciting field of Predictive Analytics.					
CO2	To analyze the tools required for Predictive Analytics.					
CO3	Evaluate data to look at data distributions and to identify data problems, including missing values.					
CO4	Apply students to have skills that will help them to solve complex real-world problems in decision support.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to NoSQL databases** Characteristics, need, and limitations of RDBMS. CAP Theorem. Overview of NoSQL data models—Key-Value, Document, Column-Family, and Graph—with examples such as Redis, MongoDB, Apache Cassandra, and Neo4j. Advantages, limitations, and comparison of SQL and NoSQL based on data model. **Introduction to MongoDB** Architecture, components, and features of MongoDB. MongoDB data modelling using embedded and referenced models with use cases. Applications of MongoDB in e-commerce, social media, analytics, and CMS.	15 Hours	CO1
2	**Basic MongoDB Operations** Introduction to MongoDB shell and data types. CRUD operations in MongoDB including insertion, updating, updating top-level and embedded fields, replacing documents, and deletion. Batch operations and document management. Querying documents including retrieving all documents, querying by fields, use of conditional and logical operators, projection, and sorting. Basic commands and limitations in querying data.	15 Hours	CO2
	Advanced MongoDB Advanced operations in MongoDB: aggregation framework for data processing and analysis. Indexing		

3	techniques and their role in query optimization. Replication using replica sets for high availability and fault tolerance. Sharding concepts including shard keys, auto-sharding, and horizontal scalability. Introduction to MongoDB deployment using cloud platforms and integration with programming environments (Java/Python) and DevOps practices.	15 Hours	CO3

Suggested Readings

1. Steve Hoberman, "Data Modelling for MongoDB", 1st Edition, Technics Publication, 2014, ISBN 9781935504702.
2. Daniel Perkins, "MongoDB", 3rd Edition, CreateSpace Independent Publishing Platform, 2016, ISBN 152396300.
3. Shakuntala Gupta Edward, "Practical MongoDB", 2nd edition, Apress Publications, 2016, ISBN 1484206487.
4. David Hows, "The definitive guide to MongoDB", 2nd edition, Apress Publication, 2009, ISBN 8132230485.

Online Resources

1. https://www.youtube.com/@GiraffeAcadem
2. https://www.youtube.com/@AnInsightfulTechie

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3		1	1								1	
CO2	2	3		2								1	
CO3	2			3								1	1
CO4	2		3	1	2							1	1

Program	B. Tech CSE (CCML)				
Year	IV	**Semester**	VIII		
CourseName	Essentials of Blockchain Technology				
Code	RPEC53841				
CourseType	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Understanding of computer science, information technology, and information security.	2	1	0	3
Course Objectives	1. Blockchain technology and key concepts, like cryptography and cryptocurrency concepts. 2. Gain an in-depth insight into Bitcoin, its network, and how Bitcoin transactions are validated by miners. 3. Interpret the prospects of Blockchain and assess how Blockchain can improve your business standards. 4. Deploy your private blockchain on the web, where you can visually see your chains & send transactions between nodes.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand how blockchain solutions are transforming the industry landscape.				
CO2	Analyse blockchain technical topics such as consensus, cryptography, privacy, and security to gain a deeper understanding.				
CO3	Evaluate hands-on expertise using popular blockchain open-source technology, including Hyperledger Fabric.				
CO4	Apply a permissioned blockchain.				

Module	CourseContents	Contact Hrs.	Mapped CO
1	**Blockchain Prerequisites and Foundation** Introduction to HTML 5 and JavaScript Programming, Concept of callback, promises and Async/Await, NodeJS-Server-side JavaScript, Docker essentials, Containers Orchestration, Implementations, Creating, and Deploying Docker containers, Fundamentals of Blockchain, cryptographic foundation, Blockchain Architecture. **Blockchain in detail** Business context of Blockchain, use cases in finance, and supply chain. Problems that Blockchain aims to solve: Enterprise Blockchain vs Public Blockchain; Permissioned vs Permissionless networks; Governance models; scalability; privacy.	15 Hours	CO1

2	**Blockchain Status and Industry Landscape:** Broad Categories of Blockchain Solutions, State of the Blockchain Industry: Technology Landscape (2019 Context), Key Topics of Focus (2019), Blockchain Communities and Ecosystem, Variations in Modern Blockchain Implementations, Indicators of Blockchain's Future. **Linux Foundation Hyperledger and Blockchain Use-Cases** Understand the background behind the Linux Foundation Hyperledger project, Enumerate and compare the different Hyperledger projects, Introduce Hyperledger Fabric, learn about some successful blockchain projects, Evaluate goodvs. bad blockchain ideas, Assess the business value.	15 Hours	CO2
3	**Blockchain Developer Part1:** Blockchain principles and enterprise relevance, Blockchain infrastructure and applications, Identify participants, assets, transactions in a business network, Access control and role-based permissions, Regulatory and compliance considerations, Hyperledger Fabric, Blockchain solution architecture, Peers, smart contracts, channels, world state. **Blockchain Developer Part2:** Consensus, ordering service and transaction endorsement, Chain code structure, lifecycle, and deployment approaches., Blockchain deployment with Docker and Kubernetes, Scaling peers and orderers, Monitoring and logging basics, Blockchain security on Hyperledger Fabric, PROJECT **Research Activities on Blockchain network:** Security audit of smart contracts, Case Studies: Blockchain-enabled cloud identity management, Intelligent security monitoring using AI and Blockchain.	15 Hours	CO3, CO4

Suggested Readings

1. IBM Courseware.
2. Implementing Blockchain solutions using Hyperledger.

Online Resources

1. https://nptel.ac.in/courses/106105184

Course Articulation Matrix													
PO-PSO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO1**	**PSO 2**
CO 1	2	2	2	2	1	1	1	1			1	2	2
CO 2	2	2	2	2	2	1		1	1		1	2	2
CO 3	2	2	1	2	2			1	1	1	1	2	1
CO 4	2	2	2	2	2	1	1	1	1	1	1	2	2

Program	B. Tech. CSE(CCML)					
Year	IV	**Semester**	VIII			
Course Name	Data Compression					
Course Code	RPEC53842					
Course Type	PEC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Multimedia	2	1	0	3	
Course Objectives	1. To provide students with contemporary knowledge in Data compression and coding.					
	2. To equip students with skills to analyze and evaluate different data compression and coding methods.					
	3. The student knows basic algorithms used in lossless and lossy compression.					
	4. The student knows basic mathematical models used in lossless and lossy compression.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Apply fundamental ideas of lossless data compression in multimedia.					
CO2	Implement and evaluate mathematical theory and algorithms.					
CO3	Analyze fundamental ideas of quantization and transform coding.					
CO4	Understand how lossless and lossy compression algorithms can be used for solving scientific and engineering problems.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Compression Techniques: Lossless and Lossy Compression, Measures of performance, Modelling and Coding; Mathematical Preliminaries for Lossless compression: A brief introduction to information theory; Models: Physical models, Probability models, Markov models, Composite source model; Coding: Uniquely decodable codes, Prefix codes.	15 Hours	CO1
2	**Huffman and Arithmetic Coding:** Huffman coding algorithm: Minimum variance Huffman codes; Adaptive Huffman coding: Update procedure, Encoding procedure, Decoding procedure; Golomb codes, Rice codes, Tunstall	15 Hours	CO2

	codes Applications of Huffman coding: Lossless image compression, Text compression and Audio Compression, Arithmetic Coding: Introduction, Coding a Sequence, Generating a Tag, Deciphering a Tag, Comparison of Huffman and Arithmetic Coding, Applications.		
3	**Mathematical Preliminaries for Lossy Coding, Dictionary Coding and Context Based Compression:** Mathematical Preliminaries for Lossy Coding: Introduction, Distortion criteria, Models., Dictionary Techniques: Introduction, Static Dictionary: Diagram Coding; Adaptive Dictionary: The LZ77 Approach, The LZW Approach, Applications: File Compression-UNIX compress, Image Compression- Graphics Interchange Format, (GIF) and Portable Network Graphics (PNG), Context Based Compression: Introduction, Prediction with Partial Match (ppm)-The basic algorithm, The ESCAPE SYMBOL, Length of context, The Exclusion Principle; The Burrows Wheeler Transform: Move-to-front coding, Dynamic Markov Compression.	15 Hours	CO3, CO4

Suggested Readings

1. Gilbert Held and Thomas R. Marshall, Data Compression: Techniques and Applications, Wiley Publication, 3rd Edition,1991.
2. Ida Mengyi Pu, Fundamental Data Compression, Butterworth-Heinemann Publication, 1st Edition, 2005.
3. David Salomon, "Data Compression", Springer Publication, 4th Edition,2007.
4. Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Series, 3rd Edition,2005.

Online Resources

1. https://www.youtube.com/watch?v=424VP3SOmi4
2. https://onlinecourses.nptel.ac.in/noc22_ee49/preview

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	3	1	1						1	2	2
CO2	3	2	2	2	1						1	2	2
CO3	1	2	3	2	2						1	2	2
CO4	2	2	1	1	1						1	2	2

Program	B. Tech CSE (CCML)				
Year	IV	**Semester**	VIII		
Course Name	Bioinformatics				
Code	RPEC53843				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Biology, Computer Fundamentals, Programming Concepts, and Statistics.	2	1	0	3
Course Objectives	1. Understanding methods and software tools for understanding biological data. 2. To analyze fundamentals of evolution, molecular biology, and molecular evolution. 3. To understand DNA, RNA important molecules, protein data, etc. their structure, replication and transcription. 4. To Evaluate the biological databases which help in analyzing biological data and their interpretation.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	To understand the basic concept of Bioinformatics and its significance in Biological data analysis.				
CO2	To Analyze properties of bio informatical databases, perform text- and sequence-based searches.				
CO3	To Apply the major steps in pair wise and multiple sequence alignment by dynamic programming.				
CO4	To Evaluate different types of Biological databases.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**: Bioinformatics objectives and overviews, Interdisciplinary nature of Bioinformatics, Data integration, Data analysis, Major Bioinformatics databases and tools. Metadata: Summary & reference systems, finding new type of data online. **Molecular Biology and Bioinformatics:** Systems approach in biology, Central dogma of molecular biology, problems in	15 Hours	CO1

	molecular approach and the bioinformatics approach, Overview of the bioinformatics applications		
2	**The Information Molecules and Information Flow:** Basic chemistry of nucleic acids, Structure of DNA, Structure of RNA, DNA Replication, -Transcription, -Translation, Genes-the functional elements in DNA, Analyzing DNA, DNA sequencing. **Proteins:** Amino acids, Protein structure, Secondary, Tertiary and Quaternary structure, Protein folding and function, Nucleic Acid-Protein interaction. **Perl:** Perl Basics, Perl applications for bioinformatics- Boiler, Linux Operating System, Understanding and Using Biological Databases, Java clients, CORBA, Introduction to biostatics	15 Hours	CO2
3	**Nucleotide sequence data:** Genome, Genomic sequencing, expressed sequence tags, gene expression, transcription factor binding sites and single nucleotide polymorphism. Computational representations of molecular biological data storage techniques: databases (flat, relational and object oriented), and controlled vocabularies, general data retrieval techniques: indices, Boolean search, fuzzy search and neighboring, application to biological data warehouses. **Biological data types and their special requirements:** Sequences, macromolecular structures, chemical compounds, generic variability and its connection to clinical data, representation of patterns and relationships: alignments, regular expressions, hierarchies and graphical models.	15 Hours	CO3, CO4

Suggested Readings

1. O'Reilly, Developing Bioinformatics Computer Skills, Indian Edition Publications, 2019.
2. Rastogi, Mendiratta, and Rastogi, Bioinformatics: Concepts, Skills and Applications, CBS Publishers, 2020.
3. Bioinformatics, Addison-Wesley Publications, 2021.

Online Resources

1. https://nptel.ac.in/courses/102103044
2. https://nptel.ac.in/courses/102106065

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	1		2							2	1
CO2	1	2	3	2	2						1	1	2
CO3	2		3	3	2						2	2	3
CO4	1	1	2	2	2						2	2	2

Program	B. Tech CSE (CCML)				
Year	IV	**Semester**	VIII		
Course Name	Pattern Recognition				
Course Code	RPEC53844				
Course Type	PEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Probability, Linear algebra, ML, Python	2	1	0	3
Course Objectives	1. Learn the fundamental concepts and applications of pattern recognition. 2. Understand the fundamental concepts of Pattern Recognition. 3. Evaluate the learning of the Models. 4. Develop some applications of pattern recognition.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the fundamental pattern recognition and machine learning theories.				
CO2	Analyze certain important pattern recognition techniques.				
CO3	Evaluate systems and algorithms for pattern recognition (signal classification), with focus on sequences of patterns.				
CO4	Applying the pattern recognition theories to applications of interest.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction:** Introduction to Pattern Recognition, Basics of pattern recognition and application, Design principles of pattern recognition system, Learning and adaptation, Types of learning in pattern recognition. Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi-squared test.	15 Hours	CO1
2	**Statistical Pattern Recognition:** Bayesian Decision Theory, Classifiers, Normal density, Discriminant functions. Parameter Estimation Methods: Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods, Principal Component Analysis (PCA), Fisher Linear Discriminant Analysis, Expectation maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models. decision boundaries in the non-parametric method.	15 Hours	CO2
3	**Nonparametric Techniques and Unsupervised Learning:** Density Estimation, Parzen Windows, K-Nearest Neighbor Estimation, Nearest Neighbor Rule, Fuzzy classification, Clustering, Criterion functions for clustering, Clustering Techniques, Iterative square - error partitioned clustering – K-means, Agglomerative hierarchical clustering, Cluster validation.	15 Hours	CO3, CO4

Suggested Readings

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", 2nd Edition, John Wiley, 2006.
2. C. M. Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer, 2009.
3. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press, 2009.

Online Resources

1. https://nptel.ac.in/courses/106106046
2. https://nptel.ac.in/courses/106108057
3. https://nptel.ac.in/courses/117106100
4. https://nptel.ac.in/courses/117108048

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3		1							1	3	2
CO2	3	2		2							1	3	2
CO3	3	1	3	2	2						1	3	2
CO4	3		3	2	1							3	2

Program	B. Tech (CSE, CSE-AI, CSE-CCML, CSE-AIBC, CSE-GenAI)				
Year	IV	Semester	VII		
Course Name	Disaster Management				
Course Code	OE53101				
Course Type	OEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Environmental Studies, Chemistry, Basic Statistics and Data Analysis	3	1	0	4
Course Objectives	1. Understand the fundamentals of disasters and hazards.				
	2. Learn the causes and impacts of natural and man-made disasters.				
	3. Develop knowledge of disaster preparedness, mitigation, and response.				
	4. Understand disaster management strategies & community resilience.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain the concepts of disasters, hazards, vulnerability, and disaster management systems.				
CO2	Analyze disaster-related data and identify the role of information and communication technologies in disaster management.				
CO3	Apply emerging technologies for disaster preparedness and response.				
CO4	Develop technology-enabled solutions for disaster risk reduction and resilience.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Disaster Management:** Introduction to Disaster Management, Concept of Environmental Hazards, Environmental stress & Environmental Disasters. Types of Environmental hazards and Disasters: Natural hazards and Man-made, Volcanic Hazards- Causes and distribution of Volcanoes, Hazardous effects of volcanic eruptions, Environmental impacts of volcanic eruptions, Earthquakes- Effects, Measures, Distribution of earthquakes, Floods- Control measures Human adjustment, Perception and Mitigation, Cyclones, Droughts- Impacts, Drought hazards in India, Drought - Control measures. Landslides, Wildfires, Biological hazards, Disaster Risk Assessment and Vulnerability Analysis	15 Hours	CO1
	Mechanics and forms of Soil Erosion: Factors & Causes of Soil Erosion, Conservation measures of Soil Erosion,		

2	Sedimentation processes, Global and Regional Sedimentation problems, Sedimentation and Environmental problems, Corrective measures of Erosion & Sedimentation, Chemical hazards-Release of toxic chemicals, Geographic Information Systems (GIS) in Disaster Management, Big Data Analytics for Disaster Monitoring. **Case Studies** on Disaster Risk Mapping.	15 Hours	CO2
3	**Pre and Post-Stages:** Pre- disaster stage (preparedness)- Preparing hazard zonation maps, Predictability-forecasting and Early Warning Systems, Artificial Intelligence and Machine Learning in Disaster Prediction Preparing disaster preparedness plan, Land use zoning, Pre-disaster stage (mitigation) Disaster resistant house construction, Population reduction in vulnerable areas, Awareness. Emergency Stage-Rescue training for search and operation at national & regional level, Immediate relief, and Assessment surveys. Post Disaster stage, Rehabilitation- Political Administrative Aspect, Drone Technology and Robotics in Disaster Response.	15 Hours	CO3
4	**Relief Measures:** Disaster Preparedness and Emergency Planning, Prediction of Hazards and Disasters, Measures of adjustment to natural hazards, Mitigation methods, Meteorological observatory, Seismological observatory, Hydrology Laboratory, Industrial Safety inspectorate, Institution of urban and regional planners, Chambers of Architects, Engineering Council, National Standards Committee, Integrated Planning Contingency management Preparedness Education on disasters, Community involvement, The adjustment of Human Population to Natural hazards & disasters, Population Explosion, Post-Disaster Recovery and Rehabilitation **Case Study:** Future Trends-AI, Digital Twins, Predictive Analytics and Smart Resilient Infrastructure	15 Hours	CO4

Suggested Readings

1. Singh. Savinder, “Environmental Geography”, Prayag Pustak Bhawan.
2. Sharma V.K., “(Ed) Disaster Management”, IIPA Publication New Delhi.
3. National Disaster Management Authority (NDMA)
4. Tripathi, K. N.& Siddiqui,B., Environmental Pollution and Human Health, Academic Guru Publishing House, New Delhi.

Online Resources

1. https://nptel.ac.in/courses/124107010
2. https://store.agphbooks.com/product/environmental-pollution-and-human-health

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	-	2	-	2	2	-	-	-	2	-	-
CO2	3	2	-	2	-	2	2	-	-	-	2	-	-
CO3	3	2	-	2	-	2	2	-	-	-	2	-	-
CO4	3	2	-	2	-	2	2	-	-	-	2	-	-

Program	B. Tech (CSE, CSE-AI, CSE-CCML, CSE-AIBC, CSE-GenAI)				
Year	IV	**Semester**			VII
Course Name	Database Administration				
Code	OE53201				
Course Type	OEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of Database Management Systems (DBMS) and SQL.	3	1	0	4
Course Objectives	1. Understand the concepts of Database Management Systems (DBMS). 2. Introduce students to database administration concepts and practices in an Oracle environment. 3. Explain Database Management Systems, their components, architectures, and models. 4. Understand and apply user roles, privileges, and database security mechanisms.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the database approach and the file-system approach, and explain DBMS components and models.				
CO2	Apply database security mechanisms, user management, storage structures, and backup and recovery techniques.				
CO3	Analyse and implement transaction management, concurrency control, and performance-tuning techniques.				
CO4	Evaluate database administration practices, automation techniques, NoSQL databases, and emerging cloud/distributed database trends.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	DBMS and RDBMS concepts, database architecture (centralized, client-server, distributed systems), ER modeling, normalization and schema design, database installation and configuration (Oracle, MySQL/PostgreSQL), database instances and network environment, introduction to cloud databases (AWS RDS, Azure SQL).	15 Hours	CO1
2	Storage structures (tablespaces, data files), indexing and partitioning, user management and authentication, roles and privileges, database security mechanisms, encryption techniques, database backup and recovery methods	15 Hours	CO2

	(RMAN, snapshots), database maintenance, auditing, data privacy and compliance basics.		
3	Transaction management, ACID properties, concurrency control, locking mechanisms, deadlocks, crash recovery, query processing, query optimization, execution plans, performance tuning techniques, database monitoring tools.	15 Hours	CO3
4	DBA roles and responsibilities, database monitoring and scaling, automation using scripts and scheduling, introduction to NoSQL databases (MongoDB), DevOps concepts for databases, containerization basics, distributed databases, big data integration, cloud-native database systems.	15 Hours	CO4

Suggested Readings

1. Teorey, T. J., Lightstone, S. S., & Nadeau, T. (2007). Physical Database Design: The Database Professional's Guide to Exploiting Indexes, Views, Storage, and More. Morgan Kaufmann (Elsevier).
2. Sciore, E. (2008). Database Design and Implementation (2nd Edition). Wiley.
3. Lewis, P. M., Bernstein, A., & Kifer, M. (2001). Databases and Transaction Processing: An Application-Oriented Approach. Addison-Wesley.

Online Resources

1. https://nptel.ac.in/courses/106105175

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	2	2	2	2							3	2
CO2	2	2	2	2	2							2	2
CO3	2	2	3	2	2							3	2
CO4	2	2	2	2	2							3	2

Program	B. Tech (CSE, CSE-AI, CSE-CCML, CSE-AIBC, CSE-GenAI)				
Year	IV	**Semester**	VII		
Course Name	Quality Management				
Code	OE53501				
Course Type	OEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic knowledge of management principles, statistics, and engineering processes.	3	1	0	4
Course Objectives	1. To develop fundamental understanding of quality concepts, evolution of quality control, TQM, and quality in design and procurement processes. 2. To impart knowledge of quality management systems, organizational structure, and the role of human factors in achieving quality improvement. 3. To equip students with statistical tools such as control charts for monitoring, analyzing, and improving manufacturing processes. 4. To enable students to understand defect diagnosis, reliability concepts, ISO standards, and modern quality improvement techniques like Taguchi and JIT.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain quality concepts, TQM principles, and evaluate procurement and manufacturing quality practices.				
CO2	Analyze the role of organizational structure and human factors in effective quality management systems.				
CO3	Apply statistical quality control techniques such as control charts to analyze process performance and capability.				
CO4	Evaluate defects, reliability, and implement quality improvement methodologies including ISO standards, Taguchi methods, and JIT.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Quality Concepts:** Evolution of Quality control, Concept change, TQM Modern concept, Quality concept in design, Review off design, Evolution of prototype. **Control on Purchased Product:** Procurement of various products, Evaluation of supplies, Capacity verification, Development of sources, Procurement procedure. **Manufacturing Quality:** Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.	15 Hours	CO1

2	**Quality Management:** Organization structure and design, Quality function, Decentralization, Designing and fitting organization for different types products, Economics of quality value and contribution, Quality cost, Optimizing quality cost. **Human Factor in Quality:** Attitude of top management, Co-operation, of groups, Operators attitude, responsibility, Causes of operator's error and corrective methods.	15 Hours	CO2
3	**Control Charts:** Theory of control charts, Measurement range, Construction and analysis of R charts, Process capability study, Use of control charts. **Attributes of Control Charts:** Defects, Construction and analysis off-chart, Improvement by control chart, Variable sample size, Construction and analysis of C-chart.	15 Hours	CO3
4	**Defects Diagnosis and Prevention:** Defect study, Identification and analysis of defects, Corrective measure, Factors affecting reliability, MTTF, Calculation of reliability, Building reliability in the product, Evaluation of reliability, Interpretation of test results, Reliability control, Maintainability, Zero defects, quality circle. **IS0-9000 and its concept of Quality Management:** ISO9000 series, Taguchi method, JIT in some details. Case Study: Building Reliability in Product Design, Maintainability in Industrial Machines, Zero Defects Approach in Manufacturing.	15 Hours	CO4

Suggested Readings

1. Kusiak, Andrew (Ed.), *Concurrent Engineering: Automation, Tools, and Techniques*, John Wiley & Sons, New York, 1993.
2. Menon, Uday V., *Concurrent Engineering*, Chapman & Hall, London, 1992.
3. Singh, Bijendra, *Quality Control and Reliability Analysis*, Khanna Publishers, New Delhi, Latest Edition.

Online Resources

1. https://archive.nptel.ac.in/courses/110/104/110104080/
2. https://nptel.ac.in/courses/110104085

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2	0	1							1	1
CO2	2	3	2	0	1							1	1
CO3	3	3	2	3	3							1	1
CO4	2	3	3	2	2							1	1

Program	B.Tech. CSE					
Year	IV	**Semester**	VII			
Course Name	Energy Management					
Code	OE53301					
Course Type	OEC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic knowledge of Engineering Mathematics	3	1	0	4	
Course Objectives	1. To understand the fundamentals of energy sources, conservation, and energy management practices. 2. To learn the principles and techniques of energy auditing and performance analysis. 3. To analyse and improve the energy efficiency of electrical, lighting, HVAC, and industrial systems. 4. To evaluate energy management solutions using economic and environmental considerations.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Understand energy sources, demand–supply, energy conservation, and basic measurement techniques.					
CO2	Apply energy management and auditing principles for data analysis and performance improvement.					
CO3	Analyze and optimize electrical, lighting, and HVAC systems for energy efficiency and comfort.					
CO4	Evaluate process and building energy systems with economic analysis for decision-making.					

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction:** Energy sources, Energy demand and supply, Energy crisis, Future scenario, Energy system efficiency, Energy conservation aspects, Instrumentation and measurements. **Principles of Energy Management and Energy Audit:** General principles, Planning and program, Introduction to energy audit, General methodology, Site surveys, and Energy systems survey, Energy audit, Instrumentation, Analysis of data and results.	15 Hours	CO1
2	**Electrical Load and Lighting Management:** General principles, Illumination and human comfort, Lighting systems, Equipment's, Electrical systems, Electrical load analysis, Peak load controls.	15 Hours	CO2

	Heating and Cooling Management: General principles of energy managements in HVAC systems, Human comforts and health requirements, HVAC systems, Boiler and heat sources, Chillers, fans, pumps, cooling towers, Modeling of heating and cooling loads in buildings, Energy management opportunities.		
3	**Process Energy Management:** Principles, Process heat, Combustion, Automatic fuel controls, Steam generation and distribution, Hot water and pumping, Furnaces and ovens, Process electricity, Compressed air, Manufacturing process, Energy storage for process industries, Process control. **Integrated Building systems:** General principles, Environment conformation, Passive design considerations, Building envelope design consideration, Integration of building system, Energy storage-cold storage techniques, Economic analysis.	15 Hours	CO3
4	**Economic Aspects of Energy Management:** General considerations, Economic analysis methods, Life-cycle costing, Break even analysis, Benefit cost analysis, Payback period analysis, Present worth analysis, Equivalent annual cost analysis, Use of computers, Management of energy with environment aspects.	15 Hours	CO4

Suggested Readings

1. S Kaushik, T Verma; Rural Energy Management; Deep and Deep Publishers; 2004.
2. W R Murphy, G Mckay, B.S.; Energy Management; Publications; 2009.
3. S. C. Patra, B.C Kurse, R. Kataki ; Renewable Energy and Energy Management; International Book Co; 2007.
4. J Piper; Operations and Maintenance Manual for Energy Management; Standard Publishers; 1999.

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	1									2
CO2	3	3	2	2	2	3						2	2
CO3	3	3	3	2	2	2						2	2
CO4	3	3	2	2	2	2						3	2

Program	B. Tech (CSE, CSE-AI, CSE-CCML, CSE-AIBC, CSE-GenAI)					
Year	IV	**Semester**	VIII			
Course Name	Concepts of Climate Smart Agriculture					
Course Code	OE53102					
Course Type	OEC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Environmental Studies, Disaster Management	3	1	0	4	
Course Objectives	1. To introduce the fundamentals of meteorology, atmospheric processes, and the principles of Climate-Smart Agriculture (CSA).					
	2. To develop an understanding of soil formation, soil properties, and their role in sustainable crop production.					
	3. To examine climate change, its impacts on agricultural systems, and adaptation strategies for resilient farming.					
	4. To explore climate-related agricultural challenges and modern approaches to water resource management and precision agriculture.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	Explain the concepts of meteorology, atmospheric composition, and Climate-Smart Agriculture and their relevance to sustainable agriculture.					
CO2	Analyse soil formation processes, physicochemical properties, and their influence on soil fertility and crop productivity.					
CO3	Assess the impacts of climate change on agricultural systems and evaluate climate-resilient crop production strategies.					
CO4	Apply water management techniques, precision agriculture tools, and climate-smart practices to address agricultural challenges under changing climatic conditions.					

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Meteorology and Climate Smart Agriculture**: Meteorology and atmosphere, structure and composition of atmosphere, atmospheric inputs (acid rain, dust), water-soil-plant relations, pollution in the environment and its effects on humans, plants and soil, climate smart agriculture and greenhouse gases.	15 Hours	CO1
2	**Soil Formation and its Physicochemical Properties:** Soil forming rocks and minerals, their classification and		CO2

	composition, important soil physical properties and their importance, soil particle distribution, soil organic matter including its composition and decomposition, effect on soil fertility, soil reaction (acidic, saline and sodic soils), soil nutrients, influence of physicochemical properties on plant health, effects of macro and micronutrients on plant growth.	15 Hours	
3	**Climate Change and its Possible Impacts:** Historical examples of crop failure, reasons and social consequences, need and strategy for development of climate smart crops, successful examples of climate smart crops, effects of climate on crops, crop growth and development in relation to environmental stress (water and temperature stress), nutrient stress and resistance mechanisms.	15 Hours	CO3
4	**Climate Challenges and Water Management:** Challenges arising due to climate change and case studies (e.g., cultivating durum wheat in Ethiopia and its mitigation), advances in crop water management for climate smart crop farming, and use of high-quality crop varieties. Precision agriculture using IoT for climate-smart farming.	15 Hours	CO4

Suggested Readings:

1. Manohar, K. R., and Thinathane, C. Iga, Green House Technology and Management, B.S. Publications, Hyderabad, 2004.
2. Benkeblia, Noureddine (Ed.), Climate Change and Crop Production: Foundations for Agroecosystem Resilience, CRC Press, Boca Raton, 2020.
3. Hebbar, K. B., Kumar, S. Naresh, and Chowdappa, P. (Eds.), Impact of Climate Change on Plantation Crops, Astrel International–Daya Publishing House, New Delhi, 2017. ISBN: 9789351248330.

Online Resources:

1. U.M. Sainju, R. Dris and B. Singh, Mineral Nutrition of Tomato, 2003. Available: www.aseanfood.info/Articles/11019991.pdf
2. Making climate-smart agriculture work for the poor Available: www.worldagroforestry.org/publication/making-climate-smart-agriculture-work-poor

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2	2	-	2		-	-	-	2	-	-
CO2	3	2	2	2	-	2		-	-	-	2	-	-
CO3	3	2	2	2	-	2		-	-	-	2	-	-
CO4	3	2	2	2	-	2		-	-	-	2	-	-

Program	B. Tech (CSE, CSE-AI, CSE-CCML, CSE-AIBC, CSE-GenAI)				
Year	IV	**Semester**	VIII		
Course Name	Computational Intelligence				
Code	OE53202				
Course Type	OEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Fundamentals of Artificial Intelligence, Probability and Statistics, and Basic Programming Concepts.	3	1	0	4
Course Objectives	1. To introduce the fundamental concepts, techniques, and applications of Computational Intelligence in solving complex real-world problems. 2. To develop an understanding of knowledge representation, reasoning mechanisms, fuzzy systems, and neural network models. 3. To explore learning paradigms, probabilistic reasoning, evolutionary computation, and intelligent decision-making techniques. 4. To enable students to apply Computational Intelligence methods in areas such as machine learning, natural language processing, and intelligent systems.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Explain the fundamental concepts of Computational Intelligence, including search strategies, expert systems, and heuristic problem-solving techniques.				
CO2	Analyze knowledge representation, reasoning mechanisms, fuzzy inference systems, and neural network models for intelligent decision-making.				
CO3	Evaluate machine learning approaches, probabilistic reasoning models, evolutionary algorithms, and neural network learning techniques for solving computational problems.				
CO4	Apply Computational Intelligence techniques to develop intelligent solutions in domains such as natural language processing, information retrieval, and machine learning applications.				

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction:** Introduction to Artificial Intelligence-Search-Heuristic Search-A* algorithm-Game Playing- Alpha-Beta Pruning-Expert Systems-Inference-Rules-Forward Chaining and Backward Chaining- Genetic Algorithms.	15 Hours	CO1

2	**Knowledge Representation and Reasoning:** Proposition Logic, First Order Predicate Logic, Unification Algorithm, Forward Chaining, Backward Chaining. Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information, Prolog Programming. **Uncertainty:** Non monotonic reasoning-Fuzzy Logic, Fuzzy rules, fuzzy inference, Temporal Logic, Temporal Reasoning, Neural Networks, Neuro-fuzzy Inference.	15 Hours	CO2
3	**Learning:** Probability basics, Bayes Rule and its Applications, Bayesian Networks, Exact and Approximate Inference in Bayesian Networks, Hidden Markov Models, Forms of Learning, Supervised Learning, Learning Decision Trees, Regression and Classification with Linear Models, Artificial Neural Networks, Nonparametric Models, Support Vector Machines, Statistical Learning, Learning with Complete Data, Learning with Hidden Variables, The EM Algorithm, Reinforcement Learning.	15 Hours	CO3
4	**Intelligence And Applications:** Natural language processing, Morphological Analysis, Syntax analysis, Semantic Analysis, Language Models, Information Retrieval, Information Extraction, Machine Translation, Machine Learning.	15 Hours	CO4

Suggested Readings

1. Andries P Engelbrecht, "Computational Intelligence: An Introduction", Wiley-Blackwell
2. Eberhart, "Computational Intelligence", Elsevier, First Edition
3. Amit Konar, "Computational Intelligence: Principles, Techniques and Applications", Springer

Online Resources

1. https://www.udemy.com/course/cipython/
2. https://nptel.ac.in/courses/106102220
3. https://nptel.ac.in/courses/106105077

Course Articulation Matrix

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	3						1	2	2
CO2	1	3	2	3	2						2	2	2
CO3	3	3	3	2	3						1	1	1
CO4	3	3	1	2	3						1	2	2

Program	B.Tech. (CSE, CSE-CCML, CSE-AI, CSE-AIBC, CSE-GenAI)				
Year	IV	**Semester**	VIII		
Course Name	Product Development				
Code	OE53502				
Course Type	OEC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic engineering knowledge and problem-solving skills	3	1	0	4
Course Objectives	1. To understand the fundamentals of product development, product planning, customer needs, and market analysis. 2. To learn product architecture, system-level design, product platforms, and requirement engineering principles. 3. To apply industrial design principles, DFMA, robust design, prototyping, and additive manufacturing techniques. 4. To develop skills in product management, value engineering, innovation, intellectual property, and product.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Analyze product development processes, customer requirements, and market needs for successful product planning.				
CO2	Design product architectures and system-level solutions based on engineering specifications and market requirements.				
CO3	Apply industrial design, DFMA, prototyping, and additive manufacturing techniques in product development.				
CO4	Evaluate product cost, value, innovation, intellectual property, and commercialization strategies for product success.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Product Development Fundamentals:** Challenges of Product Development, Successful Product Development, Product Planning Process, Product Life Cycle Management (PLM) **Customer and Market Analysis:** Market Research, Survey Techniques, Identifying Customer Needs, Customer Journey Mapping and User Personas	15 Hours	CO1
2	**Product Architecture Fundamentals**: Product Architecture, Implications of Architecture, Establishing the Architecture	15 Hours	CO2

	System Design and Product Platforms: Related System-Level Design Issues, Modular and Platform-Based Product Design, Requirement Engineering and Specifications		
3	**Industrial Design and Product Optimization**: Industrial Design overview, Design for Manufacturing and Assembly (DFMA), Robust Design **Prototyping and Advanced Manufacturing Technologies**: Prototyping, Rapid Prototyping Tools and CAD/CAM Integration, Additive Manufacturing (3D Printing)	15 Hours	CO3
4	**Product Management and Cost Optimization**: Concurrent Engineering, Product Costing, Value Engineering, Product Data Management (PDM) **Product Innovation**: Innovation and Creativity in Product Design. **Emerging Trends and Commercialization**: Intellectual Property Rights (Patents, Copyrights, Trademarks), AI and Data Analytics in Product Development, Start-up Product Development and Commercialization Strategies.	15 Hours	CO4

Suggested Readings

1. Ulrich, K. T., and Eppinger, S. D., Product Design and Development, 6th Edition, McGraw-Hill Education.
2. Chitale, A. K., and Gupta, R. C., Product Design and Manufacturing, 5th Edition, PHI Learning Pvt. Ltd., New Delhi.
3. Rao, P. N., Product Design and Manufacturing, Tata McGraw-Hill Education, New Delhi.

Online Resources

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_me81
2. https://onlinecourses-archive.nptel.ac.in/noc18_me04

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	2	1		1					1	1
CO2	3	3	3	2	2		1					1	1
CO3	2	2	3	2	3		2					1	1
CO4	2	3	2	2	2		1	1	1		3	1	1

Program	B.Tech. CSE (AI)					
Year	IV	**Semester**	VIII			
Course Name	Non-Conventional Energy Resources					
Course Code	OE53302					
Course Type	OEC	**L**	**T**	**P**	**Credit**	
Pre-Requisite	Basic understanding of energy concepts, physics, and environmental studies.	3	1	0	4	
Course Objectives	1. To understand the fundamentals of non-conventional and renewable energy resources.					
	2. To study solar energy systems, biomass energy, and their applications.					
	3. To learn the principles and operation of wind, tidal, hydrogen, and fuel cell technologies.					
	4. To explore geothermal, ocean, and other emerging renewable energy systems for sustainable power generation.					
Course Outcomes: After successful completion of the course, the students will be able to:						
CO1	To understand about Non –Conventional energy resources.					
CO2	Evaluate solar energy, make use of it, and understand the principals involved in gathering solar energy and converting it into electricity					
CO3	Study the components, kinds and performance of the wind energy conversion system to gain an understanding of the topics involved					
CO4	To understand about examples of ocean energy and describe the practical ways to use it.					

Module	**Course Contents**	**Contact Hrs.**	**Mapped CO**
1	**Introduction:** Indian and global energy sources, Energy exploited, Energy planning, Introduction to various sources of energy, Solar thermal, Photovoltaic, Water power, wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy. Solar radiations: Extraterrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, Zenith angle, solar altitude angle expression for angle between incident	15 Hours	CO1

	beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length.		
2	**Solar energy:** Solar thermal power and its conversion, Solar collectors, Flat plat, Concentric collectors, Cylindrical collectors, Thermal analysis of solar collectors. Solar energy storage, Different systems, solar pond. Applications, Water heating, Space heating & cooling, Solar distillation, solar pumping, solar cooking, Greenhouses, Solar power plants. **Biogas:** Photosynthesis, Bio gas production Aerobic and anaerobic bio-conversion process, Raw materials, Properties of bio gas, Transportation of bio gas, bio gas plant technology & status, Community biogas plants, Problems involved in bio gas production, Bio gas applications, Biomass conversion techniques, Energy plantation, Fuel properties.	15 Hours	CO2
3	**Wind energy:** Properties of wind, Availability of wind energy in India, wind Velocity, win machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill, Economic issues, Recent development. **Electrochemical effects and fuel cells:** Revisable cells, Ideal fuel cells, other types of fuel cells, Efficiency of cells, Thermions systems. **Tidal power:** Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy Limitations of tidal energy conversion systems. **Hydrogen Energy:** Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel.	15 Hours	CO3
4	**Thermoelectric systems:** Kelvin relations, power generation, Properties of thermoelectric materials, Fusion Plasma generators. **Geothermal energy:** Hot springs, Steam ejection, Principal of working, types of geothermal station with schematic representation, Site selection for geothermal	15 Hours	CO4

	power plants. Advanced concepts Problems associated with geothermal conversion. **Ocean energy:** Principal of ocean thermal energy conversion, Power plants based on ocean energy, problems associated with ocean thermal energy conversion systems.		

Suggested Readings

1. Bansal Keemann, Meliss ; Renewable energy sources and conversion technology; McGraw Hill; 2018.
2. Rai G.D.; Non-Conventional energy Sources; Khanna Publishers; 1988.
3. Ashok V. Desai; Non-conventional Energy; New Age International Private Limited; 2022.

Online Resources

1. NPTEL(SWAYAM): https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge38
2. IEEE Papers**:** https://ieeexplore.ieee.org/document/5596088

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	3	2	3	2	3						2	2
CO2	3	3	2	3	3	3						1	2
CO3	2	2	3	2	3	2						2	1
CO4	3	2	3	2	3	2						2	1

Program	Vocational Course offered by CSE Department				
Year	-	**Semester**	-		
Course Name	Programming with Python				
Code	NVC53241				
Course Type	VOC	**L**	**T**	**P**	**Credit**
Pre-Requisite	C Programming	2	0	0	2
Course Objectives	1. To develop a strong foundation in Python programming. 2. To develop analytical and problem-solving skills for real-world applications 3. Easy mapping and respective conversion of real world problems to python programs. 4. To develop the ability to work with large amounts of data for analytical purposes using Python.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Apply fundamental programming concepts using Python to solve basic computational problems.				
CO2	Utilize Python data structures and functions for efficient program development				
CO3	Develop object-oriented Python programs incorporating exception handling and modular programming.				
CO4	Implement Python-based solutions for simple data analysis and real-world applications.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Introduction to Python and Programming Fundamentals**: Overview of programming languages and Python, installation and Python development environment, Python syntax and program structure, variables and data types, type conversion, input and output operations, operators and expressions, decision-making statements including if, if-else and nested if, iterative statements including for and while loops, control statements such as break, continue and pass. **Python Data Structures and Functions:** Strings and string manipulation, lists and list operations, tuples, sets and dictionaries, indexing and slicing, user-defined functions, function arguments and return values, variable scope, recursive functions, file handling concepts, reading from and writing to text files. Python Data Structure: Tuples, Lists, List Comprehension, Sets and Dictionaries, Mutable Sequences, Unpacking Sequences,	15 Hours	CO1, CO2
2	**Object-Oriented Programming and Python Applications:** Introduction to object-oriented programming, classes and objects, constructors and methods, inheritance and polymorphism, exception handling techniques, modules and packages, introduction to NumPy and Pandas libraries, basic data analysis and visualization concepts, development of simple Python applications and mini projects.	15 Hours	CO3, CO4

Suggested Readings

1. John M. Zelle, Python Programming: An Introduction to Computer Science, Franklin, Beedle & Associates, 2017.
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist (2nd Edition), O'Reilly Media, 2015.
3. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming (3rd Edition), No Starch Press, 2023.

Online Resources

1. https://nptel.ac.in/courses/106106182
2. https://swayam.gov.in/explorer?searchText=python+programming

Course Articulation Matrix													
PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	1	1	2						1	1	1
CO2	3	3	2	2	2						2	2	2
CO3	3	3	3	2	3						2	2	2
CO4	3	3	3	2	3						2	2	2

Program	Vocational Course offered by CSE Department.				
Year		**Semester**			
Course Name	Fundamentals of Artificial Intelligence				
Code	NVC53242				
Course Type	VOC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Data Structures & Algorithms, Fundamentals of Mathematics	2	0	0	2
Course Objectives	1. Understand the basics of the theory and practice of Artificial Intelligence as a discipline and about intelligent agents. 2. The student will learn to apply knowledge representation techniques and problem-solving strategies to common AI applications 3. Study the concept behind genetic algorithm and its various operations. 4. Learn the basic concept of fuzzy set theory.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the evolution and various approaches of AI.				
CO2	Implementation of data storage, processing, visualization, and its use in regression, clustering etc.				
CO3	Analyze the concepts of neural networks.				
CO4	Apply the concepts of face, object, speech recognition and robots.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**An overview to AI:** The evolution of AI to the present, various approaches to AI, what should all engineers know about AI? Other emerging technologies, AI and ethical concerns, Existing sets of principles for AI, AI in the Organization Structure. **Data & Algorithm:** History of Data, Data storage and importance of and its acquisition, the stages of data processing, data visualization, regression, prediction & classification, clustering & recommender systems.	15 Hours	CO1, CO2
2	**Artificial Neural Networks:** Deep learning, Recurrent Neural Networks, Convolutional Neural Networks, The Universal Approximation Theorem, Generative Adversarial Networks, Speech recognition, Natural language understanding, Natural language generation, Chatbots, Machine Translation. **Applications:** Image and face recognition, Object recognition, Speech Recognition besides Computer Vision, Robots, Applications, Investments in AI and AI in start-ups, AI Strategy and Governance (agenda).	15 Hours	CO3, CO4

Suggested Readings

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Third Edition, 2009.
2. I. Bratko,-Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. M. Tim Jones, -Artificial Intelligence: A Systems Approach (Computer Science) ‖, Jones and Bartlett Publishers, Inc.; First Edition, 2008.
4. Nils J. Nilsson, ―The Quest for Artificial Intelligence‖, Cambridge University Press, 2009.
5. William F. Clocksin and Christopher S. Mellish, ‖ Programming in Prolog: Using the ISO Standard‖, Fifth Edition, Springer, 2003.
6. Gerhard Weiss, ―Multi Agent Systems‖, Second Edition, MIT Press, 2013.
7. David L. Poole and Alan K. Mackworth, -Artificial Intelligence: Foundations of Computational Agents‖, Cambridge University Press, 2010.

Online Resources

1. https://nptel.ac.in/courses/109106184
2. https://onlinecourses.nptel.ac.in/noc22_cs83/preview

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2	1	2	2						2	2	1
CO2	2	1	2	3	2						2	1	2
CO3	2	2	2	2	2						1	1	2
CO4	2	2	2	2	2						1	1	2

Program	Vocational Course offered by CSE Department				
Year	-	**Semester**	-		
Course Name	Cyber Crime and Computer Forensics				
Code	NVC53243				
Course Type	VOC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic Knowledge of Cyber Laws	2	0	0	2
Course Objectives	1. Acquainting students with Cyber Crimes. 2. Providing the students the understanding of Issues in Internet Governance. 3. To understand the different aspects of computer forensic. 4. Making the student aware of Digital Evidences and working of various Agencies for investigation of cyber-crimes in India.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Understand the basic concept of cybercrime and computer forensics.				
CO2	Analyze the virus, cyber-attacks and hacking in cyber applications.				
CO3	Evaluate the different computer forensic tools and techniques.				
CO4	Apply different methods for digital evidence related to system security.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	**Definition of Cyber Crime:** Introduction of Cyber Crime, Nature and Scope of Cyber Crime, Types of Cyber Crime, Social Engineering, Categories of Cyber Crime, Property Cyber Crime. Introduction to internet crimes: hacking and cracking, credit card and ATM frauds, emerging digital crimes and modules. Introduction to Cyber Crime Investigation, Investigation Tools, Discovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery.	15 Hours	CO1, CO2
2	**Computer forensics analysis and Tools:** Introduction to Computer Forensics Forensic Software and Hardware, Analysis and Advanced Tools, Forensic Technology and Practices, Forensic Ballistics and Photography, Face, Iris and Fingerprint Recognition, Audio Video Analysis, Windows System Forensics, Linux System Forensics, Network Forensics.	15 Hours	CO3, CO4

	Email Security And Firewalls: PGP ,S/MIME, Internet Firewalls for Trusted System- Roles of Firewalls, Firewall related terminology, Types of Firewalls, Firewall designs SET for E-Commerce Transactions.		

Suggested Readings

1. Angus M. Marshall, "Digital forensics: Digital evidence in criminal investigation", John – Wiley and Sons, 2008**.**
2. Bernadette H Schell, Clemens Martin, "Cybercrime", ABC – CLIO Inc, California, 2004. "Understanding Forensics in IT ", NIIT Ltd, 2005.
3. Nelson Phillips and EnfingerSteuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi, 2009**.**

Online Resources

1**.** https://onlinecourses.swayam2.ac.in/cec20_lb06
2**.** https://nptel.ac.in/courses/106106178

Course Articulation Matrix													
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	1	2		1							1	2	2
CO2	1	2	2	1							1	2	2
CO3	2	1	2	2	2						2	2	2
CO4	1	1	1	2	2						2	2	2

Program	Vocational course offered by CSE Department				
Year	-	**Semester**	-		
Course Name	Meta-Verse and Virtual Reality				
Code	NVC53244				
Course Type	VOC	**L**	**T**	**P**	**Credit**
Pre-Requisite	Basic computer knowledge and VR hardware.	2	0	0	2
Course Objectives	1. Understand how Augmented Reality/Virtual Reality (AR/VR) interfaces are used to interact in the Meta-verse. 2. To create AR/VR interfaces using free software tools. 3. Use AR/VR interfaces as part of a business solution to enable potential customers to interact with a company's products and services in the Meta-verse. 4. Understand how all these fit into the Meta-verse as a whole, so as to create viable business solutions in the Meta-verse.				
Course Outcomes: After successful completion of the course, the students will be able to:					
CO1	Definition of the Meta-verse & the interplay between Web 3.0 and Block chain				
CO2	Use of NFTs in Meta-verse & Industries using the Meta-verse technology				
CO3	Describe how VR systems work and list the applications of VR.				
CO4	Explain the concepts of motion and tracking in VR systems.				

Module	Course Contents	Contact Hrs.	Mapped CO
1	Introduction and class policies, What is the Meta-verse? Demo of the Meta-verse ,The Meta-verse vs. Web 3.0 AR/VR and the Meta-verse Applications of the Meta-verse advantages and Challenges of the Meta-verse Types of the Meta-verse Block chain and the Meta-verse Crypto currency and the Meta-verse NFTs and the Meta-verse	15 Hours	CO1, CO2
2	Introduction to Virtual Reality, Representing the Virtual World, The Geometry of Virtual Worlds & The Physiology of Human Vision, Visual Perception & Rendering, Motion and Tracking.	15 Hours	CO3, CO4

Suggested Readings

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.

Online Resources:

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/metaverse/
2. https://archive.nptel.ac.in/courses/106/106/106106138/

Course Articulation Matrix														
PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	1	2	1	1							1	1	1
CO2	1	2	2	2	1							2	2	2
CO3	1	1	2	2	1							2	2	2
CO4	1	2	2	2	1							2	2	2