Sri Krishna College of Engineering and Technology

An Autonomous Institution, Affiliated to Anna University

Coimbatore – 641 008

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

CURRICULUM AND SYLLABI

B.TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATION 2020

SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF
ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATION 2020

B.TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

ABOUT THE DEPARTMENT

VISION

To produce globally competitive professionals in Artificial Intelligence and Data Science by imparting cognitive learning and encouraging industry collaboration towards serving the greater cause of society.

MISSION

1. Impart knowledge in cutting edge Artificial Intelligence and Data Science technologies in par with industrial standards.
2. Inculcate research and lifelong learning that benefit society at large.
3. Promote ethical values and entrepreneurial skills.

PROGRAMME OUTCOMES (POs)

Artificial Intelligence and Data Science Graduates will be able to:

PO1 - **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 - **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 - **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and

modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 - **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 - **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 - **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 - **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1:

To build a successful career in IT/relevant industry or carryout research in advance areas of Artificial Intelligence, Data Science and address various issues in the society.

PEO 2:

To develop problem solving skills and ability to provide solution for real time problems.

PEO 3:

To develop the ability and attitude of adapting themselves to emerging technological Challenges.

PEO 4:

To excel with excellent communication skills, leadership qualities and social responsibilities.

PROGRAMME SPECIFIC OBJECTIVES (PSO)

PSO 1:

Understand, analyze and develop innovative solutions for real world problems in industry and research establishments related to Artificial Intelligence and Data Science.

PSO 2:

Ability to choose or develop the right tool for Data analysis and develop high end intelligent systems.

PSO 3:

Apply programming principles and practices for developing software solutions to meet future business and society needs.

Mapping of PO's to PEO's

Programme Educational Objectives (PEO)	Program Outcomes (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
PEO1	3	3	3	3	3	3	3	2	1	2	2	3
PEO2	3	3	3	3	3	2	2	2	2	3	3	3
PEO3	1	3	1	2	3	2	3	1	1	2	2	2
PEO4	1	1	3	2	1	3	3	3	3	3	3	1

Mapping of PO's to PSO's

Programme Specific Outcomes (PSO)	Programme Outcomes (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
PSO1	3	3	3	3	1	2	1	1	1	2	2	2

PSO2	3	3	3	1	3	1	1	1	2	2	2	3
PSO3	3	3	3	1	1	3	3	2	3	2	2	3

Mapping of PSO's & PEO's

Programme Specific Outcomes (PSO)	**Programme Educational Objectives (PEO)**			
	PEO1	PEO2	PEO3	PEO4
PSO1	3	3	2	2
PSO2	3	3	2	1
PSO3	3	2	3	3

1	Reasonably agreed	2	Moderately agreed	3	Strongly agreed

Sem	**Course Code**	**Course**	**Programme Outcomes**											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Semester 1	20AD101	Python for Data Science	3	3	3	3	3	3	1	1			1	1
	20MA101	Engineering Mathematics I	2	2	2						2			
	20CH101	Engineering Chemistry	2	2	3				2		1			
	20AD102	Computer Organization and Digital Logic	3	3	3					2				
	20AD103	Python Laboratory	3	3	3		2			2	2	2	2	3
	20ME103	Engineering Practices laboratory	3	3	3		3		3		3	2		
	20MC101	Mandatory Course-I (Induction Programme)						3	3	3	3	3	3	3
Semester 2	20GE201	Universal Human Values	2	2	2			3	3	3	2	2		2
	20MA201	Engineering Mathematics II	3	3	2						2			
	20EN101	Technical Communication Skills								1	3	3		2
	20PH104	Physics	2	1	2						1			

	20AD201	Data Structures using C	3	3	3	3	3							2
	20ME111	Engineering Graphics	2	2	1				2	2	3			2
	20MC102	Mandatory Course-II (Environmental Sciences)						2	3					
Semester 3	20AD301	Fundamentals of Operating Systems	2	2	3	3	2				2	1		2
	20IT402	Design and Analysis of Algorithms	3	3	3	3	2				2	3		2
	20CS401	Database Management Systems	2	2	3	3	2				3	2		3
	20AD302	Artificial Intelligence Principles and Techniques	3	3	3	3	3	2			3	1		3
	20MA302	Mathematical Structures	3	3	3	3	2				1			2
	20AD303	Object Oriented Programming with core Java	2	2	3	3	3		2		3	2	2	3
	20AD304	Fundamentals of Operating Systems Laboratory	2	2	3	2	3				2	2		3
	20CS405	Database Management Systems Laboratory	2	2	3	3	2				3	3		3
	20MCXXX	Mandatory Course-III	2	2	3	2	1				1	1		2
Semester 4	20AD401	Data Warehousing and Mining	2	2	3	3	2				2	3		3
	20AD402	Biology for Engineers	2	2							1	1		2
	20AD403	Introduction to Computer Networks	2	2	2	3	2				2	2		2
	20AD404	Machine Learning	2	2	3	3	2	2	2		3	3		3
	20AD405	Fundamentals of Software Engineering	1	2	3	2	3				3	3	3	3
	20MA404	Random Variables and Statistics	3	3	3	1	2				1	1		2
	20AD406	Networks Laboratory	2	2	2	3	2				2	2		2
	20AD407	Machine Learning Laboratory	2	2	3	3	2	2	2		3	3		3
	20MCXXX	Mandatory Course-IV	2	2	3	3	1	2			1	1	1	2
me ste 5	20AD501	Data Science Using R	3	3	2	3	3	2		1	1	1	1	3

	20AD502	Fundamentals of Signals and Systems	3	3	3	3	3	2			1	1	1	3
	20AD503	Cloud Computing Fundamentals	3	3	3	3	3	2	3		1	1	1	3
	20AD504	Data Science Lab	3	3	3	3	3	2			1	1	1	3
	20AD505	Mini Project –I	3	3	3	3	3	3	2	2	3	3	3	3
Semester 6	20AD601	AI in Natural Language Processing	3	3	2	3	3	2			1	1	1	3
	20AD602	Data visualization using Tableau	3	3	3	3	3	2		1	1	1	1	3
	20AD603	IoT Design and Applications	3	3	3	3	3	2	**3**		1	1	1	3
	20AD604	NLP Laboratory	3	3	3	3	3	2			1	1	1	3
	20AD605	Mini Project –II	3	3	3	3	3	3	2	2	3	3	3	3

Semester 7	20AD701	Data Analytics	3	3	2	3	3	2			1	1	1	3
	20AD702	Deep Learning and its Applications	3	3	3	3	3	2		1	1	1	1	3
	20AD703	Data Analytics Laboratory	3	3	3	3	3	2	3		1	1	1	3
	20AD704	Deep Learning Laboratory	3	3	3	3	3	2			1	1	1	3

B. TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

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SEMESTER I							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	20AD101	Python for Data Science	3/0/0	3	3	50/50	PC
THEORY CUM PRACTICAL							
2.	20MA101	Engineering Mathematics I	2/1/2	5	4	40/60	BSC
3.	20CH101	Engineering Chemistry	3/0/3	6	4.5	40/60	BSC
4.	20AD102	Computer Organization and Digital Logic	3/0/2	5	4	40/60	ESC
PRACTICAL							
5.	20AD103	Python Laboratory	0/0/3	3	1.5	40/60	PC
6	20ME103	Engineering Practices laboratory	0/0/3	3	1.5	40/60	ESC
MANDATORY COURSE							
7.	20MC101	Mandatory Course-I (Induction Programme)	3 weeks				MC
Total				**25**	**18.5**	**600**	

SEMESTER II							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	20GE201	Universal Human Values	3/0/0	3	3	50/50	HSMC
THEORY CUM PRACTICAL							
2.	20MA201	Engineering Mathematics II	2/1/2	5	4	40/60	BSC
3.	20EN101	Technical Communication Skills	2/0/2	4	3	40/60	HSMC
4.	20PH104	Physics	3/0/3	6	4.5	40/60	BSC
5.	20AD201	Data Structures using C	3/0/2	5	4	40/60	PC

PRACTICAL							
6.	20ME111	Engineering Graphics	1/0/3	4	2.5	40/60	ESC
MANDATORY COURSE							
7.	20MC102	Mandatory Course-II (Environmental Sciences)	2/0/0	2	0	0/100	MC
Total				**29**	**21**	**700**	

SEMESTER III							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	20AD301	Fundamentals of Operating Systems	3/0/0	3	3	50/50	PC
2.	20IT402	Design and Analysis of Algorithms	3/0/0	3	3	50/50	PC
3.	20CS401	Database Management Systems	3/0/0	3	3	50/50	PC
4.	20AD302	Artificial Intelligence Principles and Techniques	3/0/0	3	3	50/50	PC
THEORY CUM PRACTICAL							
5.	20MA302	Mathematical Structures	2/1/2	5	4	40/60	BSC
6.	20AD303	Object Oriented Programming with core Java	3/0/3	6	4.5	40/60	PC
PRACTICAL							
7.	20AD304	Fundamentals of Operating Systems Laboratory	0/0/3	3	1.5	40/60	PC
8.	20CS405	Database Management Systems Laboratory	0/0/3	3	1.5	40/60	PC
MANDATORY COURSE							
9.	20MCXXX	Mandatory Course-III	2/0/0	2	0	0/100	MC
Total				**31**	**23.5**	**900**	

SEMESTER IV							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	20AD401	Data Warehousing and Mining	3/0/0	3	3	50/50	PC

2.	20AD402	Biology for Engineers	3/0/0	3	3	50/50	ESC
3.	20AD403	Introduction to Computer Networks	3/0/0	3	3	50/50	ESC
4.	20AD404	Machine Learning	3/0/0	3	3	50/50	PC
5.	20AD405	Fundamentals of Software Engineering	3/0/0	3	3	50/50	HSMC
THEORY CUM PRACTICAL							
6.	20MA404	Random Variables and Statistics	2/1/2	5	4	40/60	BSC
PRACTICAL							
7.	20AD406	Networks Laboratory	0/0/3	3	1.5	40/60	ESC
8.	20AD407	Machine Learning Laboratory	0/0/3	3	1.5	40/60	PC
MANDATORY COURSE							
9.	20MCXXX	Mandatory Course-IV	2/0/0	2	0	0/100	MC
Total				**28**	**22**	**900**	

SEMESTER V							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1.	20AD501	Data Science Using R	3/0/0	3	3	50/50	PC
2.	20AD502	Fundamentals of Signals and Systems	3/0/0	3	3	50/50	ESC
3.	20AD9XX	Professional Elective –I	3/0/0	3	3	50/50	PEC
4.	20AD9XX	Professional Elective –II	3/0/0	3	3	50/50	PEC
5.	20XXXXX	Open Elective –I	2/0/2	4	3	50/50	OEC
THEORY CUM PRACTICAL							
6.	20AD503	Cloud Computing Fundamentals	3/0/3	6	4.5	40/60	PC
PRACTICAL							
7.	20AD504	Data Science Laboratory	0/0/3	3	1.5	40/60	PC
MANDATORY COURSE							

8.	20MCXXX	Mandatory Course-V	2/0/0	2	0	0/100	MC
PROJECT WORK							
9.	20AD505	Mini Project –I	0/0/2	2	1	40/60	PW
Total				**29**	**22**	**900**	

SEMESTER VI							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1.	20AD601	AI in Natural Language Processing	3/0/0	3	3	50/50	PC
2.	20AD9XX	Professional Elective –III	3/0/0	3	3	50/50	PEC
3.	20AD9XX	Professional Elective –IV	3/0/0	3	3	50/50	PEC
4.	20ADXXX	Emerging Elective –I	3/0/0	3	3	50/50	EEC
THEORY CUM PRACTICAL							
5.	20AD602	Data visualization using Tableau	3/0/3	6	4.5	40/60	PC
6.	20AD603	IoT Design and Applications	3/0/2	5	4	40/60	ESC
PRACTICAL							
7.	20AD604	NLP Laboratory	0/0/3	3	1.5	40/60	PC
PROJECT WORK							
8.	20AD605	Mini Project –II	0/0/2	2	1	40/60	PW
Total				**28**	**23**	**800**	

SEMESTER VII							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
THEORY							
1	20AD701	Data Analytics	3/0/0	3	3	50/50	PC
2.	20AD702	Deep Learning and its Applications	3/0/0	3	3	50/50	PC
3.	20AD9XX	Professional Elective –V	3/0/0	3	3	50/50	PEC

4.	20AD9XX	Professional Elective –VI	3/0/0	3	3	50/50	PEC
5.	20XXXXX	Open Elective –II	2/0/2	4	3	50/50	OEC
6.	20ADXXX	Emerging Elective –II	3/0/0	3	3	50/50	EEC
PRACTICAL							
7.	20AD703	Data Analytics Laboratory	0/0/3	3	1.5	40/60	PC
8.	20AD704	Deep Learning Laboratory	0/0/3	3	1.5	40/60	PC
EMPLOYABILITY ENHANCEMENT SKILLS							
9.	20EES01	Employability Enhancement Skills (Summer Internship / Summer Training – 4 weeks)			2	0/100	EES
Total				**25**	**23**	**900**	

SEMESTER VIII							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
Project Work							
1	20AD801	Project	0/0/24	24	12	40/60	PW
Total				**24**	**12**	**100**	

HUMANITIES (9 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1	20EN101	Technical Communication Skills	2/0/2	4	3	HSMC
2	20GE201	Universal Human Values	3/0/0	3	3	HSMC
3.	20AD405	Fundamentals of Software Engineering	3/0/0	3	3	HSMC

BASIC SCIENCES (25 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1	20MA101	Engineering Mathematics I	2/1/2	5	4	BSC
2	20CH101	Engineering Chemistry	3/0/3	6	4.5	BSC

3	20MA201	Engineering Mathematics II	2/1/2	5	4	BSC
4	20PH104	Physics	3/0/3	6	4.5	BSC
5	20MA302	Mathematical Structures	2/1/2	5	4	BSC
6	20MA404	Random Variables and Statistics	2/1/2	5	4	BSC

ENGINEERING SCIENCE (22.5 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	20AD102	Computer Organization and Digital Logic	3/0/2	5	4	ESC
2.	20ME103	Engineering Practices laboratory	0/0/3	3	1.5	ESC
3.	20ME111	Engineering Graphics	1/0/3	4	2.5	ESC
4.	20AD402	Biology for Engineers	3/0/0	3	3	ESC
5.	20AD403	Introduction to Computer Networks	3/0/0	3	3	ESC
6.	20AD406	Networks Laboratory	0/0/3	3	1.5	ESC
7.	20AD502	Fundamentals of Signals and Systems	3/0/0	3	3	ESC
8.	20AD603	IoT Design and Applications	3/0/2	5	4	ESC

PROFESSIONAL CORE (62.5 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	20AD101	Python for Data Science	3/0/0	3	3	PC
2.	20AD103	Python Laboratory	0/0/3	3	1.5	PC
3.	20AD201	Data Structures Using C	3/0/2	5	4	PC

4.	20AD301	Fundamentals of Operating Systems	3/0/0	3	3	PC
5.	20IT402	Design and Analysis of Algorithms	3/0/0	3	3	PC
6.	20CS401	Database Management Systems	3/0/0	3	3	PC
7.	20AD302	Artificial Intelligence Principles and Techniques	3/0/0	3	3	PC
8.	20AD303	Object Oriented Programming with core Java	3/0/3	6	4.5	PC
9.	20AD304	Fundamentals of Operating Systems Laboratory	0/0/3	3	1.5	PC
10.	20CS405	Database Management Systems Laboratory	0/0/3	3	1.5	PC
11.	20AD401	Data Warehousing and Mining	3/0/0	3	3	PC
12.	20AD404	Machine Learning	3/0/0	3	3	PC
13.	20AD407	Machine Learning Laboratory	0/0/3	3	1.5	PC
14.	20AD501	Data Science Using R	3/0/0	3	3	PC
15.	20AD503	Cloud Computing Fundamentals	3/0/3	6	4.5	PC
16.	20AD504	Data Science Laboratory	0/0/3	3	1.5	PC
17.	20AD601	AI in Natural Language Processing	3/0/0	3	3	PC
18.	20AD602	Data visualization using Tableau	3/0/3	6	4.5	PC
19.	20AD604	NLP Laboratory	0/0/3	3	1.5	PC
20.	20AD701	Data Analytics	3/0/0	3	3	PC
21.	20AD702	Deep Learning and its Applications	3/0/0	3	3	PC
22.	20AD703	Data Analytics Laboratory	0/0/3	3	1.5	PC
23.	20AD704	Deep Learning Laboratory	0/0/3	3	1.5	PC

PROFESSIONAL ELECTIVES (18 CREDITS)

PROFESSIONAL ELECTIVE I

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD901	Artificial Neural Networks	3/0/0	3	3	PEC
2.	20AD902	Semantic Web	3/0/0	3	3	PEC
3.	20AD903	Introduction to Distributed systems	3/0/0	3	3	PEC
4.	20AD904	Virtual Reality and Augmented Reality	3/0/0	3	3	PEC
5.	20AD905	Bio Informatics	3/0/0	3	3	PEC

PROFESSIONAL ELECTIVE II

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD906	Ethics in Data Science	3/0/0	3	3	PEC
2.	20AD907	Sentiment Analysis	3/0/0	3	3	PEC
3.	20AD908	Information Extraction and Retrieval	3/0/0	3	3	PEC
4.	20AD909	Cognitive Systems	3/0/0	3	3	PEC
5.	20AD910	Intelligent Data Base System	3/0/0	3	3	PEC

PROFESSIONAL ELECTIVE III

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD911	Image Signal processing	3/0/0	3	3	PEC
2.	20AD912	Computational Statistics for Data Science	3/0/0	3	3	PEC

3.	20AD913	Bayesian Data Analysis	3/0/0	3	3	PEC
4.	20AD914	Cluster Computing	3/0/0	3	3	PEC
5.	20AD915	Business Intelligence	3/0/0	3	3	PEC

PROFESSIONAL ELECTIVE IV

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD916	Scalable System for Data Science	3/0/0	3	3	PEC
2.	20AD917	Web and Social media Mining	3/0/0	3	3	PEC
3.	20AD918	Game Theory for Data Science	3/0/0	3	3	PEC
4.	20AD919	Edge Computing	3/0/0	3	3	PEC
5.	20AD920	Reinforcement Learning	3/0/0	3	3	PEC

PROFESSIONAL ELECTIVE V

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD921	Project Management and Finance	3/0/0	3	3	PEC
2.	20AD922	Introduction to Brain and Neuroscience	3/0/0	3	3	PEC
3.	20AD923	Intelligent Multi Agent and Expert systems	3/0/0	3	3	PEC
4.	20AD924	Data Science Applications of NLP	3/0/0	3	3	PEC
5.	20AD925	Full Stack Web Development	3/0/0	3	3	PEC

PROFESSIONAL ELECTIVE VI

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	20AD926	AI for Cyber Security	3/0/0	3	3	PEC

2.	20AD927	Quantum Artificial Intelligence	3/0/0	3	3	PEC
3.	20AD928	Advanced Database Technology and Design	3/0/0	3	3	PEC
4.	20AD929	Knowledge Representation and Reasoning	3/0/0	3	3	PEC
5.	20AD930	Database Security and Auditing	3/0/0	3	3	PEC

EMERGING ELECTIVE COURSES (6 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	20AD007	Autonomous Systems and Drones	3/0/0	3	3	EEC
2.	20AD008	Crypto currencies	3/0/0	3	3	EEC
3.	20AD009	AI in Healthcare Applications	3/0/0	3	3	EEC
4.	20AD010	Predictive Analytics	3/0/0	3	3	EEC
5.	20AD011	Computer Vision	3/0/0	3	3	EEC
6.	20AD012	Data Engineering on Google Cloud Platform	3/0/0	3	3	EEC

OPEN ELECTIVES COURSES (6 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	20AD001	Fundamentals of Database Systems	2/0/2	4	3	OEC
2.	20AD002	Information Retrieval Techniques	2/0/2	4	3	OEC
3.	20AD003	Machine Learning Algorithms in Python	2/0/2	4	3	OEC
4.	20AD004	Data Visualization using R	2/0/2	4	3	OEC
5.	20AD005	Introduction to Data Analytics	2/0/2	4	3	OEC

6.	20AD006	Introduction to Deep Learning	2/0/2	4	3	OEC

EMPLOYABILITY ENHANCEMENT SKILLS (2 CREDITS)

S.No	Course Code	Course	Duration	Credit	Category
1.	20EES01	Employability Enhancement Skills (Summer Internship / Summer Training)	4 WEEKS	2	EES

MANDATORY COURSES (NON-CREDIT)

S.No	Course Code	Course	Category
1.	20MC101	Induction Programme	MC
2.	20MC102	Environmental Sciences	MC
3.	20MC103	Soft Skills	MC
4.	20MC104	Management Organizational Behaviour	MC
5.	20MC105	General Aptitude	MC
6.	20MC106	Life Skills and Ethics	MC
7.	20MC107	Stress Management	MC
8.	20MC108	Constitution of India	MC
9.	20MC109	Essence of Indian Traditional Knowledge	MC
10.	20MC110	Biology	MC

Scheme of Distribution

S.NO	Stream	Credits/Semester								Credits	AICTE Norms
		I	II	III	IV	V	VI	VII	VIII		
1.	Humanities (HSMC)		6		3					9	12
2.	Basic Sciences(BSC)	8.5	8.5	4	4					25	24
3.	Engineering Sciences(ESC)	5.5	2.5		7.5	3	4			22.5	29
4.	Professional Core (PC)	4.5	4	19.5	7.5	9	9	9		62.5	49
5.	Professional Electives(PEC)					6	6	6		18	18
6.	Open Elective(OEC)					3		3		6	12
7.	Emerging Electives(EEC)						3	3		6	
8.	Project work (PW)					1	1		12	14	15
9.	Employability Skills							2		2	
10.	Mandatory Course (MC)									-	
Total		**18.5**	**21**	**23.5**	**22**	**22**	**23**	**23**	**12**	**165**	
AICTE(CSE)		17.5	20.5	23	22	21	22	20	15		159

20AD101	PYTHON FOR DATA SCIENCE	3/0/0/3
Nature of Course	F (Theory and Programming)	
Pre-Requisite	Nil	

Course Objectives:

1	To understand and execute Python script using types and expressions
2	To understand the difference between expressions & statements and to understand the concept of assignment semantics.
3	To utilize high level data types such as lists and dictionaries.
4	To import and utilize a module and to perform read & write operations on files.
5	To use latest python libraries for data science in real time paradigms.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Recognize the general principles and good Algorithmic problem solving.	[U]
C101.2	Read, write, execute by hand simple Python programs.	[U]
C101.3	Structure simple Python programs for solving problems.	[U]
C101.4	Decompose a Python program into functions.	[AP]
C101.5	Represent compound data using Python lists, tuples and dictionaries.	[AP]
C101.6	Read and write data from data sheets and Analyse data.	[A]

Course Contents:

Algorithmic Problem Solving, Data, Expressions and Statements: (15 Hrs)

Algorithms, Building Blocks of Algorithms (Statements, State, Control Flow, Functions), Notation(Pseudo Code, Flow Chart, Programming Language), Algorithmic Problem Solving, Simple Strategies For Developing Algorithms (Iteration, Recursion). Illustrative Problems: Find Minimum In A List, Insert A Card In A List Of Sorted Cards, Guess An Integer Number In A Range, Towers of Hanoi. **-** Python Interpreter And Interactive Mode; Values And Types: Int, Float, Boolean, String, And List; Variables, Expressions, Statements, Tuple Assignment, Precedence of Operators, Comments; Modules And Functions, Function Definition And Use, Flow of Execution, Parameters And Arguments; Illustrative Programs: Exchange The Values of Two Variables, Circulate The Values of N Variables, Distance Between Two Points.

Control Flow, Functions, Lists, Dictionaries: (15 Hrs)

Conditionals: Boolean Values And Operators, Conditional (If), Alternative (If-Else), Chained Conditional (If-Elif-Else); Iteration: State, While, For, Break, Continue, Pass; Fruitful Functions: Return Values, Parameters, Local And Global Scope, Function Composition, Recursion; Strings: String Slices, Immutability, String Functions And Methods, String Module; Lists As Arrays. Illustrative Programs: Square Root, GCD. Lists: List Operations, List Slices, List Methods, List Loop, Mutability, Aliasing, Cloning Lists, List Parameters; Tuples: Tuple Assignment, Tuple As Return Value; Dictionaries: Operations And Methods, Exception handling, Files-reading and writing

Python Libraries for Data Science: (15 Hrs)

Basics for Data Science: Loading the Data from CSV file, Cleaning the Data, Visualization, Numpy and Numpy Operations, Pandas and pandas operations, Matplotlib: types of plots.

Case study: Analyze the academic performance of students and plot a graph.

	Total Hours:	**45**

Text Books:

1	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016. (http://greenteapress.com/wp/think-python/)
2	Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3	Fabio Nelli, "Python Data Analytics: Data Analysis and science using pandas, matplotlib and python programming language", Apress.

Reference Books:

1	Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
2	Timothy A. Budd, "Exploring Python", Mc Graw Hill Education (India) Private Ltd., 2015.
3	John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.
4	Peter Morgan, "Data Analysis from scratch with python: Beginner guide using python, pandas, Numpy, SCIKIT-learn, IPython, TensorFlow and Matplotlib", AI Sciences, 2018.

Web References:

1	http://nptel.ac.in/courses/106106145/
2	https://www.codecademy.com/learn/learn-python
3	https://www.coursera.org/learn/python-data-analysis#syllabus
Online Resources:	
1	https://www.programiz.com/python-programming
2	https://www.fullstackpython.com/best-python-resources
3	https://www.youtube.com/watch?v=edvg4eHi_Mw

Assessment Method's and Levels(Based on Bloom's Taxonomy)

Formative Assessment Based on Capstone Model (Max.Marks 20)

Course Outcome	Bloom's Level	Assessment Components	Marks
C101.1	Understand	Quiz	3
C101.2	Understand	Quiz	2
C101.3	Apply	Group Discussion	5
C101.4	Apply	Problem Solving	3
C101.5	Apply	Quiz	2
C101.6	Analyze	Assignment	5

Summative Assessment Based on Continuous and End Semester Examination

Bloom's Level	Theory			End Semester Examinations [50 marks]
	CIA 1 [10 marks]	CIA 2 [10 marks]	CIA 3 [10 marks]	
Remember	30	30	20	20
Understand	40	30	30	30
Apply	30	40	50	50
Analyze				
Evaluate				
Create				

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	

20	30	50	100

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

COs	POs												PSOs		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C101.1	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C101.2	3	3	3	3	2	2	2	3			2	3	3	3	2
C101.3	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C101.4	3	3	3	3	2	2	2	3			2	3	2	2	3
C101.5	3	3	2	2	3	3	3	3			2	2	3	3	
C101.6	3	3	2	2	3	3	3	3			2	2	3	3	3

3	**Strongly Agree**	**2**	**Moderately Agreed**	**1**	**Weekly Agreed**

20MA101	ENGINEERING MATHEMATICS I	2/1/2/4
Nature of Course	J (Problem analytical)	
Pre requisites	Concept of Differentiation and Matrices	

Course Objectives:

1	To develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
2	To know about system of linear equations and its solution set and how to write down the coefficient matrix and augmented matrix of a linear system
3	To familiarize with functions of several variables applicable in many branches of engineering.
4	To find the solution of ordinary differential equations as most of the engineering problems are characterized in this form.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Recall the concepts of matrices, ordinary and partial derivatives.	[R]
C101.2	Express square matrix in the diagonal form.	[U]
C101.3	Solve systems of linear equations numerically and to find inverse matrices.	[AP]
C101.4	Apply numerical techniques effectively to analyse and visualize data to solve basic engineering-related problems.	[AP]
C101.5	Find the extreme values of the given functions to solve the engineering problems.	[AP]
C101.6	Find the solution of second and higher order differential equations connected with electric circuits and simple harmonic motion.	[AP]

Course Contents:

MATRICES: (14 Hrs)

Definition – Types of matrices – Characteristic equation – Eigenvalues and eigenvectors of a real matrices and their properties (statement only) – Cayley-Hamilton theorem (statement only) –Verification and application to find inverse and powers of real matrices – Orthogonal transformation of a real symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by Orthogonal transformation.

SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS: (16 Hrs)

Newton-Raphson method – Fixed point iteration method– Gauss-Elimination method – Gauss-Jordan method –Iterative methods of Gauss-Jacobi and Gauss-Seidel – Matrix Inversion by Gauss-Jordan method – Eigenvalue of a matrix by Power method and Jacobi method.

CALCULUS: (18 Hrs)

Concepts of limits and continuity –Functions of several variables – Total derivatives – Differentiation of implicit functions – Jacobians – Taylor series expansion – Maxima and Minima – Method of Lagrangian multipliers – Ordinary differential equations –Higher order linear differential equations with constant coefficients –Euler Cauchy's equations – Applications of ODE: Solving electrical circuits and simple harmonic motion.

Lab Component

1. Entering row vector, column vector, accessing blocks of elements in MATLAB.
2. Entering matrices, to locate matrix elements and correcting any entry through indexing in MATLAB.
3. Sum, product, transpose, inverse, determinant and rank of a matrices using MATLAB.
4. Eigenvalues and eigenvectors of a matrix using MATLAB.
5. System of linear equations in MATLAB using Gaussian elimination.
6. System of linear equations in MATLAB using matrix inverse method.
7. System of linear equations in MATLAB using linsolve.
8. First and second derivative of single variable functions using MATLAB.
9. Maxima and Minima of a function using MATLAB.
10. Higher Order Equations of constant coefficients using MATLAB.

Total Hours:(48+12)	**60**

Text Books:

1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14th Edition,Pearson, Reprint,2018
2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2018.
3	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2018.

Reference Books:

1	Veerarajan. T, "Engineering Mathematics I", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
3	N.P.Bali and Dr.ManishGoyal,"A Text book of Engineering Mathematics" 9th edition, Laxmi publications ltd, 2014.

Web References:

1	http://www.nptel.ac.in/courses/111105035
2	http://www.nptel.ac.in/courses/122104017

3	http://nptel.ac.in/courses/122102009
4	http://nptel.ac.in/courses/111107063
Online Resources:	
1	https://www.coursera.org/learn/linearalgebra2
2	https://www.coursera.org/learn/differentiation-calculus
3	https://www.coursera.org/learn/single-variable-calculus
4	https://alison.com/courses/Algebra-Functions-Expressions-and-Equations

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical& Project**	
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	**Rubric based CIA [30 Marks]**	
Remember	20	20	20	20	20
Understand	30	30	30	30	30
Apply	50	50	50	50	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C101.1	3	2	3						2				2		
C101.2	2	2	2						1				2		
C101.3	1	2	2										2	2	
C101.4	2	2	2						2				2	1	
C101.5	2	3	2						2				2	1	
C101.6	2	3	2						2				2	1	

20CH101	ENGINEERING CHEMISTRY	3 /0 /3 /4.5
Nature of Course	: E (Theory skill based)	
Pre requisites	: NIL	

Course Objectives:

1	To make the students conversant with water treatment, boiler feed water techniques.
2	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
3	To understand the principles and applications of electrochemistry and to learn electro analytical methods.
4	To understand the basic concepts, synthesis, and applications of nanomaterials.
5	To explore the synthesis and properties of important engineering plastics, energy sources and drug molecules.
6	To understand the concepts of photophysical and photochemical processes in spectroscopy.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Recall the requirements of water treatment procedures and boiler feed water for industries.	[R]
C101.2	Apply the various corrosion control techniques in real time industrial environments.	[AP]
C101.3	Understand the principle and working of reference electrodes and conductivity meters as an analyzer.	[U]
C101.4	Understand the basic concepts and applications of Nanochemistry.	[U]
C101.5	Use the knowledge of polymers, various energy sources and storage devices in engineering field.	[AP]
C101.6	Understand the principle and working of certain analytical techniques, and synthesis of some common drug molecules.	[U]

Course Contents:

Water chemistry and Corrosion: **15Hours**

Water treatment-characteristics of water-hardness-types and estimation of hardness by EDTA method with numerical problems. Boiler feed water–requirements-disadvantages of hard water. Domestic water treatment-disinfection methods (chlorination, Ozonation, UV treatment)-demineralization process–desalination-reverse osmosis. Corrosion-types–mechanism of dry and

wet corrosion-galvanic corrosion-differential aeration corrosion-protective coatings-electroplating of gold-electroless plating of nickel.

Electrochemistry and Energy sources: 15Hours

Electrochemical cells-electrolytic cell-reversible and irreversible cells – Free energy and emf, cell potentials, Nernst equation and applications. Oxidation and reduction potentials-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Nanochemistry-Basics-Comparison of molecules, nanomaterials and bulk materials; Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: Electrochemical deposition and electro spinning. Applications of nanomaterials in medicine. Energy Sources-Fuel cells (H_2-O_2). Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

Polymer chemistry, Spectroscopic techniques and Synthesis of drug molecules: 15Hours

Introduction-monomers and polymers-classification of polymers-Polymerization-types. Mechanism of addition polymerization (free radical mechanism). Plastics-classification-preparation, properties and uses of Nylon 6,6, Nylon 6, PVC, Bakelite and PET. Moulding methods- moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays (Compression moulding) and PET bottles (Blow moulding). Spectroscopy-Beer Lambert's law, principle, instrumentation, and applications of Electronic spectroscopy (UV-visible), Vibrational and rotational spectroscopy (IR) and Flame emission spectroscopy (FES). Synthesis of a commonly used drug molecule-Asprin, p-nitroaniline from acetanilide.

Field work:

Industrial visit- Water treatment plant / Sewage treatment plant / Reverse osmosis plant

Lab Components:

1	Estimation of hardness of water by EDTA method	[E]
2	Estimation of alkalinity of water sample	[E]
3	Determination of chloride content in bleaching powder	[E]
4	Estimation of dissolved oxygen in water	[E]
5	Potentiometry- determination of redox potentials and emf's	[E]
6	Conductometric titration-mixture of acids vs NaOH	[E]
7	Determination of strength of strong acid by pH metry	[E]
8	Corrosion rate of mild steel in acid medium	[E]
9	Electroplating of nickel over copper	[E]
10	Spectrophotometry-Estimation of iron in water	[E]

11	Separation of mixture of amino acids by thin layer chromatography	[E]
12	Synthesis of Nylon 66	[E]
	Total Hours:	**75**
Understanding the concepts by simple Demonstrations/Experiments:		
1	To observe the hardness of given water sample by soap solution test	
2	To view the colour of the different medium of given water sample using litmus paper test	
3	To detect the chlorine content in tap water using simple chemical method	
4	To know the presence of dissolved oxygen in given water sample using glucose by redox principle	
5	To illustrate the rate of corrosion in steel nails using acid medium	
Text Books:		
1	Dara S.S, Umare S.S, “Engineering Chemistry”, First revised Edition by S. Chand & Company Ltd., New Delhi 2015.	
2	Jain P. C. & Monica Jain., “Engineering Chemistry”, 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.	
3	Fundamentals of Molecular Spectroscopy, 4th Edition by C. N. Banwell Publishing McGraw-Hill Book Company (P) Ltd, England, 1994.	
4	Physical Chemistry, 11th Edition by P. W. Atkins Publishing Oxford University Press (P) Ltd, United Kingdom, 2018.	
5	Nanochemistry, 2nd Edition by K. Klabunde, G. Sergeev Springer Publisher, 2013.	
6	N.Krishna Murthy, Vallinayagam D.,”Engineering Chemistry” 3rd Edition by PHI Learning Pvt Ltd.,2014	
7	Sunita Rattan, A Text Book of Engineering Chemistry, Student Edition by SK Kataria Publishers, 2013.	
8	R.V.Gadag, A.Nithyananda Shetty “Engineering Chemistry” 3rd Edition PHI Learning Pvt Ltd., 2014.	
Reference Books:		
1	Shikha Agarwal., “Engineering Chemistry and Applications”, Cambridge University press, 2016.	
2	Liliya.,Bazylak.I.,Gennady.E.,Zaikov.,Haghvi.A.K.,”Polymers and Polymeric Composites” CRC Press,2014.	
3	Lefrou.,Christine.,Fabry.,Pierre.,Poignet.,Jean-claude.,”Electrochemistry – The Basics,	

	with examples" 2012 ., Springer.
4	Zaki Ahmad, Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science, 2nd Edition 2012.
5	Perez, Nestor,"Electrochemistry and Corrosion Science", Springer, 2016.
6	Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.
7	Ghazi A.Karim. "Fuels, Energy and the Environment", CRC Press, Taylor and Francis group, 2012.
Web References:	
1	http://www.analyticalinstruments.in/home/index.html
2	www.springer.com › Home › Chemistry › Electrochemistry
3	https://www.kth.se/…/electrochem/welcome-to-the-division-of-applied-electrochemistry
4	www.edx.org/
5	https://www.ntnu.edu/studies/courses
6	www.corrosionsource.com/
Online Resources:	
1 2 3 4 5 6	nptel.ac.in/courses/105104102/hardness.htm https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com – Spectroscopic technique, Colorimetry https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/113108051

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	Rubric based CIA [30 Marks]	
Remember	30	30	30	10	20
Understand	60	50	40	20	50
Apply	10	20	30	40	30
Analyse	-	-	-	30	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C101.1	2	1	1				1						1		
C101.2	2	2	2				2						2		
C101.3	3	2	3				2						3		
C101.4	2	2	3				3		1				2		
C101.5	2	2	2				2						2		
C101.6	2	2	2				2						2		

20AD102	COMPUTER ORGANIZATION AND DIGITAL LOGIC	3/0/2/4
Nature of Course	: F (Theory Programming)	
Pre requisites	: NIL	

Course Objectives:

1	To study the concepts of the basic structure and operation of a digital computer.
2	To understand the concepts of algorithmic problem solving.
3	To learn the working of different types of arithmetic operations.
4	To understand the basics of sequential logic devices and the design of sequential circuits.
5	To learn the working of different types of memories and advanced processor architecture.

Course Outcomes:

Upon completion of the course, students shall have ability to

C102.1	Encode information in binary and to manipulate Boolean functions using Boolean algebra.	[AP]
C102.2	Minimize Boolean functions and implement them using digital logic gates.	[A]
C102.3	Recognize the design of the various units of digital computers that store and process information via instructions.	[R]
C102.4	Review the functionality of all components and connectivity to the Central Processing Unit.	[U]
C102.5	Review and apply the importance and challenges of parallel processing.	[AP]
C102.6	Understand the different types of multiprocessors and functionalities.	[U]

Course Contents:

Number Systems and Boolean Algebra: (15 Hrs)

Introduction -Base Conversion-Binary codes- Complements. **Boolean Algebra**: Properties of boolean algebra-Boolean functions – Minimization of Boolean Functions using Karnaugh Maps Implementation of Logic Circuits using Gates – Code Conversion- **Combinational Logic** – Combinational circuits- Binary Adder - Subtractor - Decimal Adder - Binary Multiplier – Decoders - Encoders - **Sequential Logic**- Flip-flops, Triggering of Flip-flops, Analysis of clocked sequential circuits, Design Procedure.

Architecture Fundamentals and Memory Organization: (15 Hrs)

Organization of the Von Neumann Machine - Basic Operational Concepts of a Machine - Memory Locations and Addresses – Instruction Format - Instruction Sets, Addressing Modes and Assembly Language. Memory Organization**:** Basic Concepts, Semiconductor RAMs, ROMs, Cache memories, Performance Consideration, Virtual Memory and Memory Management requirements - Secondary

storages.

Advanced Architecture: (15 Hrs)

Parallel processing challenges – Flynn's classification – SISD, MIMD, SIMD, SPMD, and Vector Architectures – Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors – Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message - Passing Multiprocessors.

Lab Experiments:

1. Realization of Boolean Functions Using Logic Gates
2. Analysis and Synthesis of Combinational Logic Circuits
3. Design and implement combinational circuits using MSI devices:
   - 4 –bit binary adder / subtractor
   - Parity generator / checker
   - Magnitude Comparator
   - Application using multiplexers
4. Design and implementation of a simple digital system
5. Design and Implementation of Shift Registers.
6. Design and Implement synchronous counters.
7. Memory unit design and perform memory operations.
8. Interfacing of CPU and Memory

Total Hours:	**60 Hours**

Text Books:

1	David A. Patterson and John L. Hennessy Computer Organization and Design-The Hardware/Software Interface 5th edition, Morgan Kaufmann, 2013.
2	Carl Hamachar, ZvoncoVranesic and SafwatZaky, "Computer Organization", McGraw-Hill, 6th Edition 2018.
3	M. Morris R. Mano, Michael D. Ciletti, "Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog", 6th Edition, Pearson, 2018.

Reference Books:

1	William Stallings, Computer Organization and Architecture –Designing for Performance, Eighth Edition, Pearson Education, 2010.
2	John F. Wakerly, "Digital Design: Principles and Practices", 5th Edition, Pearson, 2018.

3	Donald P leach, Albert Paul Malvino, GoutamSaha,"Digital Principles and Application", 8th Edition., McGraw Hill education (India) Private Limited, 2015.
Web References:	
1	http://www.hp.com/hpinfo/newsroom/press_kits/2013/hpmoonshot2013/DS_Moonshot_System.pdf
2	https://www.hpe.com/h20195/v2/getpdf.aspx/c04168328.pdf?ver=11
3	http://documents.opto22.com/casestudies/2183_Case_Study_San_Diego_Supercomputer_Center.pdf
Online Resources:	
1	https://www.coursera.org/learn/making-architecture
2	https://www.coursera.org/learn/comparch
3	http://nptel.ac.in/video.php?subjectId=106102062
4	http://nptel.ac.in/courses/106102062/

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA1 [10 Marks]	**CIA2 [10marks]**	**CIA3 [10marks]**	**Rubric based CIA [30 Marks]**	
Remember	-	-	-	20	10
Understand	50	10	20	30	10
Apply	50	50	40	30	40
Analyze	-	40	40	20	40
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**J**	**k**	**l**	**1**	**2**	**3**
C102.1	3	3	3	3								2	3	2	1
C102.2	2	3	3	2	2							2	3	1	1

C102.3	3	3	3	2	3							2	3	3	1
C102.4	2	3	3	3	2								2	2	2
C102.5	2	2	3	1	2								3	3	2
C102.6	3	3	3	3	3							1	3	1	2

	3	Strongly agreed	2	Moderately agreed	1	Weakly agreed

20AD103	PYTHON LABORATORY	0/0/3/1.5

Nature of Course	L (Programming)
Pre-Requisite	Nil

Course Objectives:

1	To understand and execute Python script using types and expressions.
2	To understand the difference between expressions & statements and to understand
3	the concept of assignment semantics.
4	To utilize high level data types such as lists and dictionaries.
5	To import and utilize a module and to perform read & write operations on files.

Course Outcomes:

Upon completion of the course, students shall have ability to

C103.1	Recognize the general principles and good Algorithmic problem solving.	[U]
C103.2	Read, write, execute by hand simple Python programs.	[U]
C103.3	Structure simple Python programs for solving problems.	[U]
C103.4	Decompose a Python program into functions.	[AP]
C103.5	Represent compound data using Python lists, tuples and dictionaries.	[AP]
C103.6	Read and write data from data sheets and Analyse data.	[A]

Course Contents:

Laboratory Experiments:

1. Programs for Familiarizing with the syntax and basic concepts
2. Programs to perform various string operations
3. Implementing conditional, control and repetition statements.
4. Creating Functions and recursive functions.
5. Programs for Familiarizing File operations
6. Initializing Packages and implementing programs based on it
7. Creating and processing data files.
8. Implementing GUI using turtle
9. Loading Data with Numpy
10. Visualizing the data using matplot lib

Total Hours:45

Text Books:

1	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016.

	(http://greenteapress.com/wp/think-python/)
2	Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python” – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3	Fabio Nelli, ”Python Data Analytics: Data Analysis and science using pandas, matplotlib and python programming language”, Apress.

Reference Books:

1	Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd., 2016.
2	Timothy A. Budd, “Exploring Python”, Mc Graw Hill Education (India) Private Ltd., 2015.
3	John V Guttag, “Introduction to Computation and Programming Using Python’’, Revised and expanded Edition, MIT Press , 2013.
4	Peter Morgan, ”Data Analysis from scratch with python: Beginner guide using python, pandas, Numpy, SCIKIT-learn, IPython, TensorFlow and Matplotlib”, AI Sciences, 2018.

Web References:

1	http://nptel.ac.in/courses/106106145/
2	https://www.codecademy.com/learn/learn-python
3	https://www.coursera.org/learn/python-data-analysis#syllabus

Online Resources:

1	https://www.programiz.com/python-programming
2	https://www.fullstackpython.com/best-python-resources

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	**Rubric based Continuous Assessment [60 marks]**	**End Semester Examination [40 marks]**
Remember	10	10
Understand	10	10
Apply	40	40
Analyze	20	20
Evaluate	10	10

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)															
Cos	**Pos**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C103.1	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C103.2	3	3	3	3	2	2	2	3			2	3	3	3	2
C103.3	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C103.4	3	3	3	3	2	2	2	3			2	3	2	2	3
C103.5	3	3	2	2	3	3	3	3			2	2	3	3	
C103.6	3	3	2	2	3	3	3	3			2	2	3	3	3

20ME103	ENGINEERING PRACTICES LABORATORY	0/0/3/1.5

Nature of Course	Practical application
Pre Requisites	Nil

Course Objectives:

1	To learn the use of basic hand tools and to know the need for safety in work place and to gain hands on experience in Carpentry, Sheet metal, Plumbing, Welding and Foundry.
2	To learn about basic electrical devices, meters and electronics devices and to gain knowledge about the fundamentals of various electrical and electronic gadgets their working and trouble shooting.

Course Outcomes:

Upon completion of the course, students shall have ability to

C103.1	Identify and solve the basic engineering problems at home and in workplace.	[AP]
C103.2	Develop the surfaces and make simple components like tray and funnel.	[C]
C103.3	Make simple metal joints using welding equipment and wooden joints using carpentry tools.	[AP]
C103.4	Prepare pipe connections and sand moulds.	[AP]
C103.5	Understand the fundamentals of hot forging and injection moulding	[U]
C103.6	Examine and troubleshoot electrical and electronic circuits	[A]

Course Contents:

GROUP A (CIVIL & MECHANICAL)

Manufacturing Methods –Sheet metal operations – Welding – arc welding, gas welding, Study of TIG & MIG welding. Study of foundry, Demonstration of Smithy and Injection moulding – Carpentry work using power tools – Plumbing components and pipelines

List of Experiments:

S.No	List of Experiments	CO Mapping	RBT
1	Preparation of butt joints and lap joints using arc welding	C103.3	[AP]
2	Sheet metal Forming and Bending, Model making – Trays and funnels.	C103.2	[C]
3	Preparation of wooden joints by sawing, planning and cutting.	C103.3	[AP]
4	Making basic pipe connections involving the fittings like valves,	C103.4	[AP]

	taps, coupling, unions, reducers, elbows and other components used in household fittings.		
5	Demonstration of foundry operations like mould preparation for solid and split piece pattern.	C103.4	[U]
6	Demonstration of Smithy operations	C103.5	[AP]
7	Demonstration of assembly of pump / Demonstration of Injection moulding	C103.5	[AP]

GROUP B (ELECTRICAL AND ELECTRONICS ENGINEERING)

List of Experiments:

Basic Circuit Elements: Resistor, inductor, capacitor. Introduction to measuring equipments: Moving iron meter, moving coil meter, Wattmeter, Energy meter, CRO, Multi-meter. Digital logic circuits, PCB design, fuse, relay, circuit breaker, wire, Earthing, fan, fluorescent lamp, iron box, mixer grinder, study of FM radio and mobile phone.

S.No.	List of Experiments	CO Mapping	RBT
1	Study and identification of electronic components with specification.	C103.6	[U]
2	Testing of CRO and Electronic components using Multimeter.	C103.6	[A]
3	Generation and measurement of signals using CRO.	C103.6	[A]
4	Familiarisation of digital basic gate IC's.	C103.6	[AP]
5	Soldering practice-components devices and circuits-using general purpose PCB.	C103.6	[AP]
6	Demonstration of meters and electrical components.	C103.6	[AP]
7	Safety precautions with electrical components.	C103.6	[AP]
8	Residential house wiring.	C103.6	[A]
9	Measurement of power and energy.	C103.6	[A]
10	Trouble shooting of electrical equipments.	C103.6	[A]

Total Hours:45

Reference Books:

1	Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology",

	Pearson Education, Inc. 2009 (Second Indian Reprint).
2	Hajra Choudhury, “Elements of Workshop Technology”, Vol. I & II, Media Promotors Pvt Ltd., 2014.
3	Suyambazhagan S, ‘Engineering practices’ PHI Learning private limited, New Delhi, 2012.
4	D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
5	E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.

Web References:

1	www.nptel.ac.in
2	www.sme.org
3	http://www.allaboutcircuits.com/education/

Tentative Assessment Methods & Levels (based on Bloom’s Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Rubric based Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Remember	10	10
Understand	10	10
Apply	40	40
Analyze	20	20
Evaluate	10	10

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

Cos	Pos												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C103.1	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C103.2	3	3	3	3	2	2	2	3			2	3	3	3	2
C103.3	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C103.4	3	3	3	3	2	2	2	3			2	3	2	2	3
C103.5	3	3	2	2	3	3	3	3			2	2	3	3	
C103.6	3	3	2	2	3	3	3	3			2	2	3	3	3

20GE201	UNIVERSAL HUMAN VALUES	3 /0 /0 /3
Nature of Course	F (Theory)	
Pre requisites	Interpersonal Communication and Value Sciences	

Course Objectives:

1	Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
3	Strengthening of self-reflection.
4	Development of commitment and courage to act.
5	Helping the students to appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings
6	Highlighting plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature

Course Outcomes:

Upon completion of the course, students shall have ability to

C201.1	Understand about themselves and their surroundings (family, society, nature).	[U]
C201.2	Understand and take responsibilities in life and handle problems to attain sustainable solutions while keeping human relationships and human nature in mind.	[U]
C201.3	Apply responsibilities towards their commitments (human values, human relationship and human society).	[AP]
C201.4	Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	[AP]
C201.5	Analyse ethical and unethical practices, and formulate strategies to actualize a harmonious environment wherever they work.	[AN]
C201.6	Understand the harmony in nature and existence, and work out mutually on fulfilling participation in the nature.	[U]

Course Contents:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being - Harmony in Myself! 15 Hours

Purpose and motivation for the course. Self-Exploration–Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and

Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Understanding human being as a co-existence of the sentient 'I' and the 'Material Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical Facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of 'I' with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail-Programs to ensure Sanyam and Health.

Module 2: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship, Understanding Harmony in the Nature and Existence - Whole existence as Coexistence 15 Hours

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and Competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all- pervasive space. Holistic perception of harmony at all levels of existence.

Module 3: Implications of the above Holistic Understanding of Harmony on Professional Ethics 15 Hours

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems. Case studies of typical holistic technologies, management models and eco-friendly production systems. Strategy for transition from the present state to Universal Human Order: a. Individual level: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations. Sum up.

Total Hours:30

Text Books:

1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010
2	Rajni Setia, Priyanka Sharma, " Human Values", Genius Publication", Jaipur,2019.

Reference Books:

1	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
2	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
3	India Wins Freedom - Maulana Abdul Kalam Azad.

Web References:

1	https://examupdates.in/professional-ethics-and-human-values/
2	http://hvpe1.blogspot.com/2016/06/notes-human-values-and-professional.html
3	https://www.yourmorals.org/schwartz.2006.basic%20human%20values.pdf

Online Resources:

1	https://nptel.ac.in/courses/109/104/109104068/
2	https://medium.com/the-mission/the-12-important-life-skills-i-wish-id-learned-in-school-f4593b49445b
3	https://www.thebalancecareers.com/life-skills-list-and-examples-4147222

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C201.1	Understand	Group Discussion	5
C201.2	Understand	Book Review	5
C201.3&4	Apply	Role Play	5
C201.5&6	Apply	Formal Presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	Term End Assessment [50 marks]
Remember	20	20	20	20

Understand	40	40	40	40
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

COs	POs												PSOs		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C201.1	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C201.2	3	3	3	3	2	2	2	3			2	3	3	3	2
C201.3	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C201.4	3	3	3	3	2	2	2	3			2	3	2	2	3
C201.5	3	3	2	2	3	3	3	3			2	2	3	3	
C201.6	3	3	2	2	3	3	3	3			2	2	3	3	3

20MA201	ENGINEERING MATHEMATICS II	2/1/2/4
Nature of Course	J (Problem analytical)	
Pre requisites	Concepts of Differentiation and Integration.	

Course Objectives:

1	To gain knowledge in integrals, which are needed in engineering applications.
2	To develop logical thinking and analytical skills in evaluating multiple integrals.
3	To acquaint with the concepts of vector calculus needed for problems in all engineering disciplines.
4	To impart the knowledge of Laplace transform, to find solutions of initial value problems for linear ordinary differential equations.

Course Outcomes:

Upon completion of the course, students shall have ability to

C201.1	Determine the area and volume by applying the techniques of double and triple integrals.	[R]
C201.2	Finding the values of integrals through different numerical methods.	[U]
C201.3	Differentiate and integrate a vector-valued functions to solve real world applications.	[AP]
C201.4	Calculate grad, div, curl and use Gauss, Stokes and Greens theorem to simplify the calculations of integrals.	[AP]
C201.5	Apply Laplace transform techniques in system modelling, digital signal processing, process control, solving boundary value problems.	[AP]
C201.6	Apply Laplace transform methods for solving linear differential equations.	[AP]

Course Contents:

INTEGRAL CALCULUS: (18 Hrs)

Definite integrals: Evaluation of definite integrals using Bernoulli's formula –Multiple Integrals: Double integration in Cartesian coordinates –Area as double integral –Change of order of Integration – Triple integration in Cartesian co-ordinates –Volume as triple integral –Beta and Gamma functions – Relation between Beta and Gamma Functions – Evaluation of Integrals using Beta and Gamma Functions – Numerical integration: Trapezoidal rule and Simpson's rule for single and double integrals.

VECTOR CALCULUS: (14 Hrs)

Vector differential operator – Gradient of a scalar point function - Directional derivatives –Divergence and Curl of a vector point function – Irrotational and solenoidal vector fields –Simple problems – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (theorems statements only)– Simple applications involving cubes and rectangular parallelepipeds.

LAPLACE TRANSFORM: (16 Hrs)

Convergence of Laplace transform – Transform of some standard functions –Unit step function – Unit Impulse function – Properties – Initial and final value theorem – Inverse Laplace transform – Partial fraction method – Convolution theorem – Application of Laplace transform for solving second order ordinary differential equation.

Lab Components:

1. Double integrals evaluation in cartesian coordinates using MATLAB.
2. Triple integral calculations using MATLAB in cartesian and cylindrical coordinates.
3. Double integral evaluation in MATLAB by Trapezoidal rule.
4. Evaluation of gradient, curl and divergence in MATLAB.
5. Line integral over a vector field using MATLAB
6. Applying Green's theorem to solve integrals in MATLAB.
7. Relation between Laplace transform of function and its derivative using MATLAB.
8. Laplace transform of Dirac delta and Heaviside functions in MATLAB.
9. Solving Differential Equations in MATLAB using Laplace Transform.
10. Inverse Laplace Transform of symbolic expressions using MATLAB.

Total Hours:(48+12): 60

Text Books:

1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14thEdition, Pearson, Reprint,2018.
2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2018.
3	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2014.

Reference Books:

1	Veerarajan. T, "Engineering Mathematics II",Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.

2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
3	N.P.Bali and Dr.ManishGoyal,"A Text book of Engineering Mathematics" 9th edition, Laxmi publications ltd, 2014.

Web References:

1	http://nptel.ac.in/video.php?subjectId=122107037
2	http://nptel.ac.in/courses/122107036/
3	http://nptel.ac.in/video.php?subjectId=117102060

Online Resources:

1	https://www.coursera.org/learn/pre-calculus
2	https://www.coursera.org/learn/linearalgebra1
3	https://alison.com/courses/Advanced-Mathematics-1
4	https://www.edx.org/course/algebra-lineal-mexicox-acf-0903-1x.

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical& Project	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	Rubric based CIA [30 Marks]	
Remember	20	20	20	20	20
Understand	30	30	30	30	30
Apply	50	50	50	50	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C201.1	2	2	2										2		

C201.2	2	1	2										1		
C201.3	3	3	2										2		
C201.4	3	3	2											1	
C201.5	3	3	2						2					2	
C201.5	3	3	2						2					2	

20EN101	TECHNICAL COMMUNICATION SKILLS	2/0/2/3
Nature of Course	: E (Theory Skill Based)	
Pre requisites	Basics of English Language	

Course Objectives:

1	To enhance learners' LSRW skills.
2	To develop effective communication skills.
3	To facilitate learners to acquire effective technical writing skills.
4	To prepare learners for placement and competitive exams.
5	To facilitate effective language skills for academic purposes and real-life situations.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Remember language skills for technical communication.	[R]
C101.2	Apply communication skills in corporate environment.	[AP]
C101.3	Understand and communicate effectively in personal and professional situation.	[AP]
C101.4	Understand and analyse a variety of reading strategies to foster comprehension and to construct meaningful and relevant connections to the text.	[U]
C101.5	Apply technical writing skills to write letters, emails and prepare technical documents.	[AP]
C101.6	Apply language skills with ease in academic and real-life situations.	[AP]

Course Contents:

Listening and Speaking: (17 Hrs)

Introduction to Effective Communication- Basics of English Language - Importance of LSRW Skills - Self Introduction - Introducing Others - **Listening** to Short Conversations or Monologues - Listening to Speeches / Talks - Listening and Responding -- Longer Listening Tasks -Recognise Functions **Speaking**- Speaking about Giving Directions / Instruction - Talk about Preferences-Agree and Disagree - Giving Opinions - Speaking Practices by Giving Examples, Reasons and Additional Information- Short Talk on Business Topics- Non Verbal Communication- Presentation using Digital Tools- Effectiveness of Narration- Leadership, Conflict and Persuasion.

Reading: (13 Hrs)

Reading Short Texts - Skimming and Scanning - Comparing Facts and Figures - Reading and Understanding Specific Information in a Text - Cloze Reading - Identifying Reasons and Consequences Through Reading Practices - Comprehension - Collocations.

Grammar and Writing: **(15 Hrs)**

Parts of Speech- Tenses – Subject Verb Agreement - Sentence Structures - Connectives - Modal Verbs - Question Formation - If Conditionals- Active and Passive - Impersonal Passive Voice - Vocabulary Building - Business Vocabulary -- Synonyms, Antonyms – British and American Words - One Word Substitution- Identifying Common Errors. Writing Formal Letters (Accepting and Declining Invitations) - Writing Business Letters (Calling for Quotation, Seeking Clarification, Placing an Order and Complaint Letter) - Email Writing – Memo - Circular - Agenda and Minutes of the Meeting - Job Application Letter - Resume Writing - Paragraph Writing – Proof Reading and Editing--Technical Instructions and Recommendations- Jumbled Sentences - Technical Definitions - Report Phrases - Report Writing - Technical Proposal - Transcoding (Bar Chart, Flow Chart).

Lab Components

1	Listening Comprehension	[E]
2	Pronunciation, Intonation, Stress and Rhythm	[E]
3	Situational Dialogues	[E]
4	Formal Presentation	[E]
5	Group Discussion	[E]
6	Interview Skills- Online and Offline	[E]
	Total Hours:	**60**

Text Books:

1	Practical English Usage. Michael Swan. OUP. 1995.
2	Remedial English Grammar. F.T. Wood. Macmillan.2007
3	On Writing Well. William Zinsser. Harper Resource Book. 2001
4	Dr. Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.

Reference Books:

1	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Web References:

1	http://www.academiccourses.com/Courses/English/Business-English
2	https://**steptest**.in

Online Resources:

1	https://www.coursera.org/specializations/business-english
2	http://www.academiccourses.com/Courses/English/Business-English
3	https://scoop.eduncle.com/one-word-substitution-list

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	**Rubric based CIA [30 Marks]**	
Remember	20	20	20	20	20
Understand	40	40	40	40	40
Apply	40	40	40	40	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C101.1									2	3		2			2
C101.2									3	3		1			1
C101.3								2	2	2		1			1
C101.4								1	1	2					1
C101.5								1	3	3		2			2
C101.6								1	3	3		2			2

20PH104	PHYSICS	3/0/3/4.5

Nature of Course	: E (Theory skill based)
Prerequisites	: Nil

Course Objectives:

1.	To learn the fundamental concepts of physics and apply this knowledge to both scientific and engineering problems.
2.	To make the students enrich basic knowledge in various fields such as Laser, Optical fibers, Photonics, Superconductors and quantum mechanics of physics and apply the same in computing fields.

Course Outcomes:

Upon completion of the course, students shall have the ability to

C104.1	Recall and interpret the basic concepts of lasers and various types of optical fibers for articulating in engineering applications.	[R]
C104.2	Describe and conduct experiments in photonic materials.	[U]
C104.3	Acquire basic understanding and fundamental concepts of superconductors.	[R]
C104.4	Discuss the dual nature of radiation and matter.	[U]
C104.5	Solve Schrodinger's equations on finite and infinite potential well problems.	[AP]
C104.6	Apply quantum idea for understanding the working of quantum computing.	[AP]

Course Contents:

Laser and Fiber optics: (15 Hrs)

Laser: Characteristics of laser – Principle of spontaneous emission and stimulated emission – Einstein's theory of matter radiation interaction and A and B coefficients (derivation) – Population inversion – Pumping –Nd-YAG and CO_2 laser – Applications: Laser printer, Data storage and Bar code scanner. ***Fiber optics:*** Light propagation through fibers, acceptance angle, numerical aperture –Types of fibers: step index, graded index, single mode and multimode– Optical fibers for computing applications–PC to PC communication and fiber optics in computer networking.

Photonics and Superconductors: (15 Hrs)

Photonics: Introduction to photonic materials – Photonic crystals – Liquid crystal display (LCD) Light sources: Light emitting diode (LED) –Photo dependence resistor– Photo detectors: PIN, avalanche – Photo voltaic effect, Solar cell – Applications of photonic materials in computing – optical computing. ***Superconductors:*** Properties of Superconductors: effect of magnetic field, Meissner effect, effect of current, thermal properties, isotope effect, Josephson effects and its applications – Type–I and Type–II Superconductors –BCS theory–High T_C superconductors –Application of Superconductors: magnetic

levitation, SQUID and cryotron.

Quantum Mechanics and Quantum computing: (15 Hrs)

Quantum Mechanics: Planck's quantum theory (derivation) – Matter waves, de-Broglie wavelength, Heisenberg's uncertainty principle –Schrödinger's wave equation: time independent and time dependent – Physical significance of wave function –Particle in a one-dimensional potential box– Electron microscope: SEM and TEM–Postulates of quantum mechanics. ***Quantum computing*****:** Introduction to quantum computing–qubits, entanglement, decoherence and quantum supermacy, differences in quantum and classical computation.

Lab Component		**30 Hours**
1	Particle size determination and measurement of d-spacing in CD using Laser.	[U]
2	Determination of wavelength, angle of divergence and coherence length of laser source.	[U]
3	Determination of numerical aperture and acceptance angle parameter of optical fiber using Laser source.	[U]
4	Characteristics curves of solar cell.	[U]
5	Characteristics curve of light dependent resistor (LDR).	[U]
6	Determination of bandgap of semiconductor.	[U]
7	Determination and verification of Stefan law.	[U]
8	Determination of Planck's constant using electroluminescence.	[U]
9	Determination of entangled photons using spectrometer.	[U]
10	Determination of wavelength of mercury spectrum – Spectrometer	[U]
	Life Skills Experiments	
1	How does a fuel (gas/liquid) pump nozzle shut off?	
2	How does a circuit breaker work?	
3	How to Check Earthing at Home?	
		Total Hours: 75

Text Books:	
1	Rajendran, V "Engineering Physics" Mc Graw Hill Publications ltd, New Delhi, 2016.
2	David Halliday, Robert Resnick, Jearl Walker "Fundamentals of Physics", 11th edition, Wiley, 2018.
Reference Books:	
1	William T. Silfvast "Laser Fundamentals" Cambridge University Press, 2012

2	FedorMitschke “Fiber Optics physics and Technology”, 2nd edition, Springer, 2017.
3	Chakrabarti P. “Optical Fiber Communication”, McGraw Hill Education,2015.
4	Kasap,Safa, Capper, “Handbook of Electronic and Photonic Materials” 2nd edition, Springer, 2017.
5	Balkan, Naci, Erol, Ayşe, “Semiconductors for Optoelectronics”, 1st edition Springer, 2020.
6	Bhattacharya D. K. and Poonam Tandon, “Engineering Physics”, Oxford University press, 2014
7	David J. Griffiths, “Introduction to Quantum Mechanics”, 2nd edition , Cambridge university press, 2017.
8	Chris Bernhardt, “Quantum Computing for Everyone” The MIT press, 2019

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	Rubric based CIA [30 Marks]	
Remember	30	20	30	20	30
Understand	60	60	60	40	60
Apply	10	20	10	30	10
Analyse	-	-	-	10	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C104.1	2	1	1										1		
C104.2	1	1	1										1		
C104.3	2	1	2											2	
C104.4	2	1	2											2	
C104.5	3	2	3						1				2	2	
C104.6	3	2	3						1				2	2	

20AD201	DATA STRUCTURES USING C	3/0/2/4
Nature of Course	: F (Theory Programming)	
Pre requisites	: Fundamentals of Problem Solving	

Course Objectives:

1	To learn the features of C
2	To handle functions, pointers, structures, unions and files using C
3	To manipulate linear and non-linear data structures
4	To explore the applications of linear and non-linear data structures
5	To familiarize the concepts of hashing.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C201.1	Develop C programs for any real-world technical application using basic programming construct, arrays and strings	[AP]
C201.2	Apply advanced features of C in solving problems	[AP]
C201.3	Design applications using sequential and random-access file processing	[AP]
C201.4	Demonstrate operations like insertion, deletion, searching, traversing etc. on linear and non- linear data structures	[AP]
C201.5	Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.	[AP]
C201.6	Choose appropriate data structure for any real-world data set.	[A]

Course Contents:

MODULE I: C PROGRAMMING: (15 Hrs)

Basic Features: Introduction -Data Types – Variables – Operations – Expressions and Statements – Conditional and Iterative Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays- Strings. ***Advanced Features:*** Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Storage classes - Preprocessor Directives.

MODULE II: LINEAR DATA STRUCTURES – LIST, STACK, QUEUE: (15 Hrs)

Abstract Data Types (ADTs) – List ADT – Array based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly linked lists – Application of lists – Polynomial Manipulation. Stack ADT – Operations – Applications – Evaluating arithmetic expressions – Conversion of

Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – Applications of queues.

MODULE III: NON-LINEAR DATA STRUCTURES: (15 Hrs)

Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Graphs- Breadth First traversal - Depth- first traversal- Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.

Laboratory Component:

S.No.	List of Experiments
1.	Practice of C Programming using Branching and Iterative constructs.
2.	Programs using Functions and Arrays
3.	Programs using Structures and Pointers.
4.	Implementation of Stack using Arrays
5.	Implementation of Stack using Linked List.
6.	Implementation of Queue using Arrays
7.	Implementation of Queue using Linked List.
8.	Implementation of Binary Search Tree.
9.	Implementation of hashing techniques

Total Hours: 60 Hours

Text Books:

1	YashavantKanetkar, “Let us C”, 15th Edition, BPB Publications, 2017
2	ReemaThareja, “Programming in C”, 2nd Edition, Oxford University Press, 2016.
3	PradipDey and ManasGhosh, “Programming in C”, 2nd Edition, Oxford University Press, 2011.
4	Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Pearson Education India, 3rd Edition 2013.

Reference Books:

1	Ellis Horowitz, SartajSahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, 2nd Edition, University Press, 2008
2	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education, 1983.
3	Robert Kruse, C.L.Tondo, Bruce Leung, ShashiMogalla , “Data Structures and Program Design in C”, 2nd Edition, Pearson Education, 2007

4	Jean-Paul Tremblay and Paul G. Sorenson, “An Introduction to Data Structures with Applications”, 2nd Edition, Tata McGraw-Hill, 1991.
5	Seymour Lipschutz, “ Data Structures by Schaum series”, 2nd Edition, Tata McGraw Hill, 2013.
Web References:	
1	http://www.nptel.ac.in
2	https://visualgo.net/en
Online Resources:	
1	https://www.youtube.com/watch?v=-CpG3oATGIs
2	http://lcm.csa.iisc.ernet.in/dsa/dsa.html
4	http://freevideolectures.com/Course/2519/C-Programming-and-Data-Structures
5	http://freevideolectures.com/Course/2279/Data-Structures-And-Algorithms

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA1 [10 Marks]	CIA2 [10 marks]	CIA3 [10 marks]	Rubric based CIA [30 Marks]	
Remember	-	-	-	-	-
Understand	50	10	20	-	10
Apply	50	50	40	30	50
Analyze	-	40	40	20	40
Evaluate	-	-	-	20	-
Create	-	-	-	30	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C201.1	3	3	1	1	2								3	1	2
C201.2	3	3	2	1	1								3	1	2

C201.3	3	3	1	2	1								3	2	3
C201.4	3	3	3	3	2								3	1	1
C201.5	3	3	3	3	2								3	1	1
C201.6	3	3	3	3	2								3	1	1
			3	Strongly agreed		2	Moderately agreed				1	Weakly agreed			

20ME111	ENGINEERING GRAPHICS	1/0/3/2.5

Nature of Course	Practical application
Pre - Requisites	Basic Drawing and Computer Knowledge

Course Objectives:

1	To know the method to construct the conic curves used in engineering applications.
2	To develop an understanding of Isometric to orthographic views and vice versa.
3	To learn the basic projection of straight lines and plane surfaces.
4	To develop the imagination of solids inclined to one reference plane.
5	To know the development of surfaces used in various fields.

Course Outcomes:

Upon completion of the course, students shall have ability to

C111.1	Understand the basic concepts of Engineering Graphics.	[U]
C111.2	Sketch isometric, orthographic projections and projection of lines and planes	[AP]
C111.3	Develop lateral surfaces of solids including prisms and pyramids	[AP]
C111.4	Construct projections of lines, planes, solids and isometric views using modelling software.	[A]

Course Contents:

Conic curves and special curves – Isometric projections, Isometric to orthographic projection-Orthographic to Isometric projection-Projection of lines and plane surfaces-Projection of solids-Development of surfaces-Introduction to perspective projection.

S.No	List of Experiments	CO Mapping	RBT
1	Introduction to drafting software.	C111.1	U
2	Construction of conic curves (Ellipse, Parabola and Hyperbola)	C111.1	U
3	Construction of special curves (Cycloid and Involutes)	C111.1	U
4	Isometric to orthographic projections – manual sketches	C111.2	AP
5	Isometric to orthographic projections – software sketches	C111.4	A
6	Projection of lines - inclined to HP, VP and Both HP & VP	C111.4	A
7	Projection of plane surfaces (Hexagon, Pentagon and circle) – inclined to any one of the principle planes	C111.4	A

8	Projection of solids (Prism and Pyramid) – inclined to HP	C111.3	AP
9	Projection of solids (Cone and Cylinder) – inclined to VP	C111.3	AP
10	Development of surfaces (Prism, Pyramid, Cone and Cylinder)	C111.4	A
11	Introduction to perspective projection	C111.2	U
			Total Hours:45

Reference Books:

1	Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2014.
2	K. V. Natarajan, "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, 2018.
3	Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2011.
4	Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2013.

Web References:

1	http://nptel.ac.in/courses/112102101/
2	www.solidworks.com

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [60 marks]**	**End Semester Examination [40 marks]**
Remember	30	30
Understand	30	30
Apply	20	20
Analyze	20	20
Evaluate	0	0
Create	0	0

Course Outcome (CO)		**Programme Outcomes (PO)**											**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C111.1	2	2	1				2	2	3			2	3	2	
C111.2	2	2	1				2	2	3			2	3	2	
C111.3	2	2	1				2	2	3			2	3	2	
C111.4	2	2	1				2	2	3			2	3	2	

20AD301	FUNDAMENTALS OF OPERATING SYSTEMS	3 / 0 / 0 / 3

Nature of Course:	G - Theory analytical
Pre requisites:	Computer Architecture and Digital Logic

Course Objectives:

1	To understand the design principles of Operating System.
2	To describe the mechanisms of OS to handle processes and threads and their communication.
3	To explore the various scheduling approaches and to provide solutions for concurrency, deadlock and starvation.
4	To identify the mechanisms involved in Memory management and its schemes.
5	To analyze the various I/O and File management techniques.
6	To understand the basics of Embedded OS, Computer Security threats and distributed systems

Course Outcomes:
Upon completion of the course, students shall have ability to

C301.1	Identify the basic concepts and design issues of operating systems.	[R]
C301.2	Understand the principles of process and threads.	[U]
C301.3	Illustrate the approaches in scheduling and deadlocks to apply in real world problems.	[AP]
C301.4	Apply concepts of memory management including Virtual Memory to the issues that occur in Real time applications.	[AP]
C301.5	Identify issues related to IO hardware, file system and disk management	[U]

Course Contents:

Computer System Overview: Operating System Functions and design issues – The Evolution of Operating Systems – Developments leading to Modern Operating Systems – Virtual Machine – OS design considerations for Multiprocessor and Multicore – Process description and control – Threads.

Concurrency and Memory: Mutual Exclusion and Synchronization – Deadlock and Starvation – Uniprocessor Scheduling – Multiprocessor and Real-Time Scheduling – Memory Management requirements – Memory partitioning – Paging – Segmentation – Virtual Memory.

Input / Output and File Systems: I/O Devices – Organization of the I/O Function - OS design issues – I/O Buffering – Disk Scheduling – RAID – Dish Cache – File Management Overview – File Organization and Access – B-Trees – File Directories – File Sharing – Record Blocking – Secondary Storage Management - File System Security.

Case Study: Embedded Operating Systems – Operating System Security – Distributed Processing – Client/Server Computing and Clusters.

	Total Hours:	**45**
Text Books:		
1.	William Stallings, “Operating Systems – Internals and Design Principles”, 9th Edition, Pearson Publications, 2017.	
2.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne, “Operating System Concepts”, 10th Edition, John Wiley, 2018	
Reference Books:		
1	Andrew S. Tanenbaum, Modern Operating Systems 5th Edition, Pearson Education, 2016.	
2	D.M Dhamdhere, “Operating Systems”- A Concept based Approach, 3rd Edition, McGraw Hill, 2017.	
Web References:		
1	http://geeksforgeeks.org/Operating Systems	
2	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/	
Online Resources:		
1	https://www.coursera.org/learn/os-power-user	
2	https://nptel.ac.in/courses/106108101/	
3	https://learn.saylor.org/course/CS401	

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C301.1	Remember	Quiz	5
C301.2	Understand	Assignment	5
C301.3, C301.4	Apply	Case Study	5
C301.5	Understand	Presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA - I [10 Marks]	CIA - II [10 Marks]	CIA - III [10 Marks]	
Remember	40	30	20	20
Understand	40	40	40	30
Apply	20	30	40	50
Analyze	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C301.1	1	1	1									2			2
C301.2	3	3	2									3			2
C301.3	3	3	2									2			3
C301.4	3	3	2									3			3
C301.5	3	3	2									3			2

20IT402	DESIGN AND ANALYSIS OF ALGORITHMS	3 / 0 / 0 / 3

Nature of Course:	F (Theory Programming)
Pre requisites:	Data Structures

Course Objectives:

1	To understand the techniques for analyzing the computer algorithms.
2	To learn the paradigms for designing the algorithms.
3	To analyze the efficiency of various algorithm design techniques / paradigms for the same problem.
4	To understand the limitations of algorithmic power.

Course Outcomes:
Upon completion of the course, students shall have ability to

C402.1	Recognize the general principles and good algorithm design techniques for developing efficient algorithms.	[R]
C402.2	Estimate the time and space complexities of algorithms.	[U]
C402.3	Apply the mathematical preliminaries to analysis and design stages of different types of algorithms.	[AP]
C402.4	Analyze efficient algorithms for various problems.	[AN]
C402.5	Distinguish the time and space complexities of different types of algorithms.	[AN]
C402.6	Differentiate between different data structures and pick an appropriate data structure for a design situation.	[AN]

Course Contents:

Fundamentals of Algorithm Analysis:

Notion of an Algorithm – Importance & role of algorithms in computing – General steps in Algorithmic problem solving – Analysis of Algorithm efficiency: Analysis Framework or Parameters, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis for Non- Recursive and Recursive Algorithms, Empirical Analysis of Algorithm. Brute Force Approach: Selection Sort - Bubble Sort - Sequential Search - String Matching - Boyer Moore algorithm.

Advanced Design Paradigms:

Decrease and Conquer Technique: Insertion sort - Topological sort. Divide and Conquer Technique: Merge sort - Quick sort - Binary search - Strassen's Matrix Multiplication. Dynamic Programming: Knapsack Problem and Memory functions - Optimal Binary Search Trees - Warshall's and Floyd's Algorithms- Matrix chain multiplication problem. Greedy Technique: Prims Algorithms - Kruskal's

Algorithm - Dijkstra's Algorithm - Huffman Trees and Codes – Sparse Matrix - Bloom Filter.

Limitations and Coping with the Limitations of Algorithm Power:

Lower - Bound Arguments -P, NP and NP-Complete Problems. Backtracking: n-Queen Problem - Hamiltonian Circuit Problem - Subset Sum Problem. Branch and Bound Technique: Assignment Problem - Knapsack Problem - Travelling Salesman Problem. Approximation Algorithms: Vertex-cover problem - Travelling Salesman Problem.

Total Hours:	**45**

Text Books:

1.	Anany Levitin, "Introduction to Design and Analysis of Algorithms", Pearson Publications, 3rd Edition, 2012.
2.	Thomas H.Cormen, Charles E.Leiserson, R.L.Rivest, "Introduction to Algorithms", Prentice Hall of India Publications, 3rd Edition, 2009.

Reference Books:

1	Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Computer Algorithms/ C++", 2nd Edition, Universities Press, 2019.
2	Sara Baase and Allen Van Gelder, "Computer Algorithms: Introduction to Design and Analysis", Pearson Publications, 3rd Edition, 2008.

Web References:

1	https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
2	https://www.coursera.org/learn/introduction-to-algorithms
3	https://timroughgarden.org/videos.html

Online Resources:

1	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
2	https://www.csa.iisc.ac.in/~barman/daa18/E0225.html
3	https://freevideolectures.com/course/2281/design-and-analysis-of-algorithms

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C402.1, C402.2	Remember, Understand	Quiz	10

C402.3	Apply	Quiz	
C402.4, C402.5	Analyze	Tutorial	10
C402.6	Analyze	Tutorial	

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment [30 Marks]**			**End Semester Examination [50 Marks]**
	Theory			
	CIA-1 [10 Marks]	**CIA-2 [10 Marks]**	**CIA-3 [10 Marks]**	
Remember	50		10	10
Understand	50		10	10
Apply	-	50	40	40
Analyse	-	50	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C402.1	3	2	2		2						2	1	3	2	1
C402.2	3	2	3		2							1	3	2	1
C402.3	3	3	3		2						1	1	3	2	1
C402.4	3	2	3		2							1	3	2	2
C402.5	3	2	2	1	2							2	3	2	2
C402.6	3	2	2									1	3	2	2

20CS401	DATABASE MANAGEMENT SYSTEMS	3 / 0 / 0 /3

Nature of Course	G (Theory Analytical)
Pre-Requisite	Nil

Course Objectives:

1	To distinguish the different types of data models and use ER diagram to conceptualize the database system.
2	To illustrate the implementation of relational database design concepts using SQL
3	To employ the normalization concepts to improve the database design.
4	To explain the techniques for query evaluation and optimization.
5	To discuss the various concurrency control techniques and recovery schemes for transaction processing

Course Outcomes:

Upon completion of the course, students shall have ability to

C401.1	Differentiate database system with file system and design ER diagram for the real-world scenarios.	[U]
C401.2	Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.	[AP]
C401.3	Apply different normal forms to retrieve the data efficiently by removing anomalies	[AP]
C401.4	Demonstrate the different storage structures and accessing techniques.	[U]
C401.5	Apply the techniques for query optimization and evaluation of algebraic expressions.	[AP]
C401.6	Examine the concepts of Transaction processing, concurrency locking protocols and understand the basics of NoSQL.	[A]

Course Contents:

Module 1: **20 Hours**

Data Modeling and Relational Query Language

Introduction– File systems vs Database systems- Users of database systems- Three level DBMS Architecture and Data Abstraction- Data Independence-Database system architecture –Introductions to data models –Hierarchical Model-Network model-Object oriented model- Entity–Relationship mode-Relational Model –Relational Algebra – Relational Calculus –Fundamental operations-SQL constructs-DDL,DML,TCL,DCL-Keys and Integrity constraints – Views – Joins-Writing optimized queries - Introduction to PL/SQL – Procedures – Functions – Triggers-Cursor.

Module 2: **15 Hours**

Relational Database Design, Storage Techniques and Query Processing

Introduction – Functional Dependency-Types of functional dependency-Closure- Undesirable Properties of Relations –Normal forms (1NF, 2NF, 3NF & BCNF)- Desirable properties of Decompositions -Indexing and Index types – B+ Tree- Hashing – Static Hashing – Dynamic Hashing-Introduction to Query Processing – Steps in query processing –Query Optimization techniques - Issues in query optimization.

Module 3: **10 Hours**

Transactions and Advanced concepts

Transaction Concepts – Transaction model – ACID Properties – Serializability- Concurrent transactions - Concurrency control – Lock based protocols- Failure Classification-Recovery Schemes-Distributed Databases-Introduction to NoSQL-NoSQL categories-MongoDB

Total Hours: 45

Text Books:

1.	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, 7th Edition, Tata McGraw Hill, March 2019.
2.	Gupta G K, “Database Management Systems”, Tata McGraw Hill Education Private Limited, New Delhi, 2011

Reference Books:

1.	Ramez Elmasri, Shamkat B.Mavathe, ”Database Systems”, 6th edition, Pearson Education,2013.
2.	Michael McLaughlin , ”Oracle Database 12c PL/SQL Programming”, Tata McGraw Hill Education Private Limited, New Delhi, 2014.
3.	GauravVaish, “Getting Started with NoSQL”, Packt Publishing, March 2013

Web References:

1	http://www.sqlcourse.com/
2	http://www.edureka.co/mongodb
3	https://alison.com/courses/IT-Management-Software-and-Databases

Online Resources:

1	https://www.coursera.org/learn/database-management
2	https://www.udemy.com/database-management-system/
3	http://www.nptelvideos.in/2012/11/database-management-system.html

Assessment Methods & Levels (based on Blooms ‘Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C401.1, C401.5, C401.6	Apply	Quiz	5
C401.2, C401.3, C401.4	Apply	Assignment	10
C401.6	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment [30 Marks]**			**End Semester Examination [50 Marks]**
	Theory			
	CIA-1 [10 Marks]	**CIA-2 [10 Marks]**	**CIA-3 [10 Marks]**	
Remember	30	20	20	20
Understand	30	40	20	20
Apply	40	40	20	40
Analyze	-	-	40	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C401.1	2	2	2								2	2	2	2	2
C401.2	2	2	2								2	2	2	2	2
C401.3	2	2	2								2	2	2	2	2
C401.4	2	3	3								2	2	2	3	2
C401.5	3	3	3								2	3	3	2	2
C401.6	3	3	2								3	3	2	3	2

20AD302	ARTIFICIAL INTELLIGENCE PRINCIPLES AND TECHNIQUES	3 / 0 / 0 / 3
Nature of Course:	H (Theory technology)	
Pre requisites:	NIL	

Course Objectives:

1	To understand the main approaches to artificial intelligence.
2	To Explore areas of application based on knowledge representation
3	To Develop abilities to apply, build and modify decision models to solve real problems.
4	To Familiarize the Artificial Intelligence techniques for building well-engineered and efficient intelligent systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C302.1	Understand the importance of agents with its types.	[U]
C302.2	Analyze the various search strategies in the problems.	[AN]
C302.3	Explain the knowledge representation, problem solving, and learning methods of artificial intelligence.	[U]
C302.4	Analyze the knowledge of AI applications.	[AN]
C302.5	Understand the basics of an expert system.	[U]

Course Contents:

Overview of Artificial Intelligence and Agents: Introduction to AI, Types of AI, Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents. **Problem Solving:** Defining the problem as state space search, production system, problem characteristics and issues in the design of search programs.Problem solving agents, searching for solutions.

Search techniques: Uninformed search strategies: breadth first search, depth first search, depth limited search, bidirectional search. Heuristic search strategies: Greedy best-first search, A* search, AO* search, memory bounded heuristic search, Optimization problems: Hill climbing search, simulated annealing search, local beam search. **Constraint satisfaction problems:** Adversarial search,optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, iterative deepening. **Knowledge & reasoning:** Knowledge representation issues, representation, approaches to knowledge representation.

Representing Knowledge: Using predicate logic, representing simple fact in logic, representing instant &

ISA relationship, computable functions & predicates, resolution, natural deduction. Representing knowledge using rules, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning. **Probabilistic reasoning:** Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Planning Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques. **Expert Systems**: Architecture, Roles of Expert System.

	Total Hours: 45

Text Books:

1.	Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill- 2008.
2.	Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007.

Reference Books:

1.	Rich E, Knight K, Nair S B, Artificial Intelligence, 3rd edition, Tata McGraw-Hill, 2009.
2.	Luger George F, Artificial Intelligence: Structures and Strategies for Complex problem solving, 6th edition, Pearson Education, 2009.
3.	Carter M, Minds and Computers: An Introduction to the Philosophy of Artificial Intelligence, Edinburgh University Press, 2007.
4.	Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.

Web References:

1.	http://www.nptelvideos.in/2012/11/artificial-intelligence.html
2.	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm
3.	https://nptel.ac.in/courses/106105077/

Online Resources:

1.	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_agents_and_environments.htm
2.	https://www.geeksforgeeks.org/artificial-intelligence-an-introduction/

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks

C302.1	Understand	Quiz	5
C302.2 & C302.5	Analyse	Assignment	10
C302.3& C302.4	Understand	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination (Theory) [50 marks]
	Theory			
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	-	-	-	-
Understand	60	50	50	50
Apply	-	-	-	-
Analyse	40	50	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C302.1	2			1						1			3	1	
C302.2	2	1	1	1						1	1		2	2	
C302.3	2	1	1	1						1	1		1	2	
C302.4	2	1	1	1						2	2		2	1	
C302.5	2	1	1	1						1	1		1	1	

20MA302	MATHEMATICAL STRUCTURES	2/1/2/4
Nature of Course	J (Problem analytical)	
Prerequisites	Higher secondary mathematics	

Course Objectives:

1	To study the concepts needed to test the logic of a program.
2	To learn the working on class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.
3	To use number theory in computer networks and security.
4	To acquire thorough knowledge of fundamental notions from lattice theory and properties of lattices.

Course Outcomes:

Upon completion of the course, students shall have ability to

C302.1	Recall the basic concepts of logic, Sets, Relations, Functions and Number theory.	[R]
C302.2	Acquire critical thinking skills by understanding the logical structure of the language.	[U]
C302.3	Use the concepts of Discrete Mathematics in software development and hardware design.	[AP]
C302.4	Demonstrate the fundamental Concepts of sets, relations, mathematical functions and all of its properties.	[AP]
C302.5	Apply discrete mathematics in formal representation of various computing constructs and algebraic structures.	[AP]
C302.6	Apply integrated approach to number theory.	[AP]

Course Contents:

Module 1: Propositional and Predicate Calculus **15 hrs**

Propositional Calculus: Basic concepts – Propositions - Connectives– Truth tables – Tautologies and Contradictions –Contrapositive – Logical equivalences and Implications – Normal forms – Principal conjunctive and Disjunctive normal forms– Rules of inference – Validity of arguments –**Predicate Calculus**: Statement function – Variables – Free and bound variables – Quantifiers– Universe of discourse – Theory of inference – The rules of universal specification and generalization – Validity of arguments.

Module 2: Set Theory **15 hrs**

Sets: Basic sets - Operations on Sets – Law on Sets - Cartesian product of sets – **Relations**: Types of

relations and their properties– Relational matrix and graph of a relation – Equivalence relations – Partial ordering-**Functions:** Classification of functions–Composition of functions–Inverse function- **Counting**: Permutations and Combinations.

Module 3: Lattices and Number Theory **15 hrs**

Lattices: Partially ordered sets - Hasse diagram - Lattices and their properties - **Number Theory:** Division algorithm-Base-b representations- Number patterns-Prime and composite numbers-GCD-Euclidean algorithm-Fundamental theorem of arithmetic-LCM-Wilson's Theorem-Fermat's Theorem-Tau and Sigma Function.

Course Outcomes: (Laboratory)

Upon the completion of the course, students shall have ability to

C302.1	Construct mathematical arguments using logical connectives and quantifiers.
C302.2	Verify the correctness of an argument using propositional and predicate logic and truth tables.
C302.3	Understand the basic principles of sets and operations in sets.
C302.4	Demonstrate the ability to solve problems using counting techniques and combinatorics in the context of discrete probability.
C302.5	Evaluate the problems in Number Theory.
C302.6	Evaluate quotients and remainders from division Algorithm.

Laboratory Component:

S.No	List of Experiments	CO Mapping	RBT
1.	Generate the truth table for mathematical logic using suitable mathematical software.	C302.1	[AP]
2.	Assign the truth table actions to decisions using suitable mathematical software	C302.2	[AP]
3.	Examine the logical validity of the arguments using suitable mathematical software.	C302.2	[AP]
4.	Using logical operators to test truth values of statements in suitable mathematical software	C302.2	[AP]
5.	Verification of De-Morgan's law using suitable mathematical software	C302.3	[AP]

6.	Set operations using suitable mathematical software.	C302.3	[AP]
7.	Compute permutations functions using suitable mathematical software.	C302.4	[AP]
8.	Compute combinations functions using suitable mathematical software.	C302.4	[AP]
9.	Compute prime and composite numbers using suitable mathematical software.	C302.5	[AP]
10.	Compute Least common multiple of two integers using suitable mathematical software.	C302.5	[AP]
11.	Compute Greatest common divisor of two integers using suitable mathematical software.	C302.5	[AP]
12.	Compute Quotient and remainder of two integers by division algorithm using suitable mathematical software.	C302.6	[AP]

Total Hours: 60

Text Books:

1	Tremblay J.P and Manohar R, —Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw–Hill Pub. Co. Ltd, New Delhi, 30th Reprint, 2011
2	Kenneth H.Rosen, —Discrete Mathematics and its Applications, Seventh Edition, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, Seventh Edition, 2017.
3	Koshy .T-"Elementary Number Theory with Applications. Elsevier Publications, New Delhi,Second Edition, 2007.

Reference Books:

1	Ralph.P.Grimaldi, —Discrete and Combinatorial Mathematics: An Applied Introduction, Fifth Edition, Pearson Education Asia, New Delhi, Fifth Edition, 2019.
2	Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, —Discrete Mathematical Structures, sixth edition , Pearson Education Pvt Ltd., New Delhi, 2017
3	Thomas Koshy, —Discrete Mathematics with Applications, Elsevier Publications, 2004.
4	David Houcque-Introduction to MATLAB for Engineering Students -2005

Web References:

1	https://nptel.ac.in/courses/111/107/111107058/
2	https://nptel.ac.in/courses/106/106/106106094/

3	https://nptel.ac.in/courses/106/106/106106183/
4	https://nptel.ac.in/courses/111/101/111101137/
Online Resources:	
1	http://discrete.openmathbooks.org/dmoi3.html
2	https://www.csie.ntu.edu.tw/~sylee/courses/dm/resources.htm
3	https://www.maa.org/press/ebooks/resources-for-teaching-discrete-mathematics

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical& Project	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	Rubric based CIA [30 Marks]	
Remember	20	20	20	20	20
Understand	30	30	30	30	30
Apply	50	50	50	50	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C302.1	1	1		1	1								1		
C302.2	2	2		2	2								1		
C302.3	3	3		3	3								1		
C302.4	3	3		3	3								1		
C302.5	3	3		3	3								1		
C302.6	3	3		3	3								1		

20AD303	OBJECT ORIENTED PROGRAMMING WITH CORE JAVA	3 / 0 / 3 / 4.5

Nature of Course	F (Theory Programming)
Pre-Requisite	Nil

Course Objectives:

1	To understand Object Oriented programming concepts and basics of java
2	To employ different types of constructors, Inheritance, polymorphism and Interfaces
3	To understand and develop packages and to implement real time applications using Exception Handling and Multithreading
4	To implement Java Database connectivity to solve real world problems
5	To understand the concepts of Annotations and Collection Framework

Course Outcomes:

Upon completion of the course, students shall have ability to:

C303.1	Identify and reproduce the features of Object-Oriented programming paradigm.	[R]
C303.2	Illustrate the usage of different kinds of constructor in real world scenarios, handling arrays and strings.	[AP]
C303.3	Apply polymorphism, Inheritance, packages and interface concepts by handling exceptions to solve real time problems in Multithreaded environment.	[AP]
C303.4	Implement Java Database connectivity to perform CRUD operations	[AP]
C303.5	Utilize the functionalities of Annotations and Collection Framework	[AP]

Course Contents:

Introduction to Object Oriented Programming: **15 Hours**

Object Oriented Programming Features - Benefits of Object-Oriented Methodology – Overview of Object-oriented programming Languages - JAVA: Introduction to Java Programming –Features of Java- Classes and Objects - Arrays – Methods -Constructor-Access Specifier – Static members - Command Line Arguments**-** Strings Handling.

Packages, Exception Handling and Multithreading **15 Hours**

Method Overloading - Method Overriding - Inheritance Types Interfaces - Final Classes and Methods- Abstract Classes- Packages- Exceptions Handling-Thread class & Runnable Interface. Inter Thread Communication, Synchronization of threads using Synchronized keyword and lock method.

JDBC, Annotations and Generics **15 Hours**

Introduction to JDBC, Steps to connect, MYSQL (CRUD) Operations. Annotation - Basics of annotation. The Annotated element Interface. Using Default Values, Marker Annotations. Single-Member Annotations, Built- In Annotations. GENERICS: Basics, Generics and type safety Collections Interfaces –Collection, Set, List, Queue, Collections Classes – Array List, Hash Set, Tree Set. Accessing a Collection via Iterators. Map Interfaces. Map Classes– AbstractMap, HashMap, TreeMap.

Laboratory Component:

S.No.	List of Experiments
1.	Basic Java Program.
2.	Implementation of Student application using Class and Objects
3.	Implementation of Bank Loan Processing using Parameterized Constructors
4.	Implement a Java program to perform String operations.
5.	Implement a Java program using polymorphism
6.	Implementation of Library Management System using Inheritance Concept.
7.	Implement a java program using interface
8.	Design a java package for numbers. Develop two different classes that belong to the number package, one class for checking if a given number is odd or even, another class is used for checking palindrome or not and access these classes using one main class.
9.	Implementation of Exception Handling mechanism using try and catch block
10.	Implementation of Multi-threading for generation of Prime Numbers and Fibonacci Series
11.	Implementation of Java Database Connectivity to perform CRUD operation
12.	Implementation of a Java Program to include all type of annotations
13.	Implementation of a java program using Set Interface.
14.	Implementation of a java program using List Interface.
15.	Implementation of a java program using Map Interface.

Total Hours: 90 Hours

Text Books:

1.	Herbert Schildt.” The Complete Reference C++” 5th Edition, Tata McGraw Hill, 2012.
2	Herbert Schildt, “Java : The Complete Reference”, 9th edition, Tata McGraw Hill, 2014.

Reference Books:

1	Scott Mayers, Effective Modern C++ “, O'Reilly Media , 1st Edition ,2014.
2	Paul Deitel, Harvey Deitel, ”Java How To Program”, 10th Edition, Prentice Hall Publications,2014.
3	Y. Daniel Liang ,”Introduction to Java Programming”,9th Edition , Prentice Hall Publications ,2015

Web References:

1	http://www.nptel.ac.in
2	http://www.javaworld.com

Online Resources:

1	https://www.coursera.org/learn/c-plus-plus-a
2	https://www.coursera.org/learn/c-plus-plus-b
3	https://www.coursera.org/learn/object-oriented-java
4	https://www.coursera.org/specializations/java-object-oriented

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Summative assessment based on Continuous and End Semester Examination

	Continuous Assessment				
	Theory			**Practical**	**End Semester Examination [40 Marks]**
Bloom’s Level	**CIA1 (10)**	**CIA2 (10)**	**CIA3 (10)**	**Rubric based CIA [30 Marks]**	
Remember	10	10	10	-	10
Understand	45	50	50	30	40
Apply	45	40	40	70	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Summative Assessment			**Total**
Continuous Assessment	**Rubric based CIA**	**End Semester Examination**	
30	30	40	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C303.1	2	2	2						2			2	2		2
C303.2	3	3	3					2	2	2		2	2	2	2
C303.3	2	2	3		2				2			3			3
C303.4	3	2	2		2			2	2	2		3		2	3
C303.5	3	2	2		2			2	2	2		3		2	3

20AD304	FUNDAMENTALS OF OPERATING SYSTEMS LABORATORY	0 / 0 / 3 / 1.5

Nature of Course	M (Practical Application)
Pre requisites	Operating Systems Internals and Design principles

Course Objectives:

1	To have insight knowledge on different Unix Utilities and system calls
2	To experience the practical side of the functioning of various blocks in OS
3	To design, simulate and debug various functionalities of operating System such as Process Scheduling and Synchronization
4	To apply and analyze Deadlock, Memory Management and Disk Scheduling Techniques for real world problems

Course Outcomes:

Upon completion of the course, students shall have ability to

C304.1	Demonstrate the use of basic Unix commands and shell programming	[U]
C304.2	Analyze the efficiency of CPU Scheduling algorithms	[A]
C304.3	Apply synchronization techniques to processes	[AP]
C304.4	Analyze the efficiency of Deadlock Prevention and avoidance mechanisms.	[A]
C304.5	Apply disk scheduling, Memory and File Management Techniques to processes	[AP]

List of Experiments:

1. Analysis of basic UNIX Commands
2. Implementation of Simple Shell Scripts
3. Synthesis of Process, Directory and I/O management Unix System Calls
4. Simulation and Analysis of Scheduling Algorithms
5. Implement ion of Threading & Synchronization Applications
6. Simulation of Deadlock Avoidance and Detection algorithm.
7. Implementation of Memory Allocation and Management Techniques
8. Implementation of Page Replacement Techniques
9. Simulation of Disk Scheduling Algorithms
10. Implementation of File organization and allocation strategies

Total Hours:	**45**

Text Books:

1	William Stallings, “Operating Systems – Internals and Design Principles”, 9th Edition, Pearson Publications, 2017.
2	Abraham Silberschatz, Peter B. Galvin, Greg Gagne, “Operating System Concepts” 10th Edition, John Wiley.
Reference Books:	
1.	Andrew S. Tanenbaum, Modern Operating Systems 5th Edition, Pearson Education, 2016.
2.	D.M Dhamdhere, “Operating Systems”- A Concept based Approach, 3rd Edition, McGraw Hill, 2017.
Web References:	
1	http://geeksforgeeks.org/Operating Systems
2	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/
Online Resources:	
1	https://www.coursera.org/learn/os-power-user
2	https://nptel.ac.in/courses/106108101/
3	https://learn.saylor.org/course/CS401

Assessment Methods & Levels (based on BloomsTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Blooms Level’s	**Rubric based Continuous Assessment [60 marks] (in%)**	**End Semester Examination [40 marks] (in %)**
Remember	-	-
Understand	20	20
Apply	60	60
Analyse	20	20
Evaluate	-	-
Create	-	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C304.1	3	3	3					3	3	3		3			3

C304.2	3	3	3					3	2	3		3			3
C304.3	3	3	3					3	3	3		3			3
C304.4	3	3	3					3	3	3		3			3
C304.5	2	3	3					2	3	2		3			2

20CS405	DATABASE MANAGEMENTS SYSTEMS LABORATORY	0/0/3/1.5
Nature of Course	M (Practical Application)	
Pre-Requisite	Nil	

Course Objectives:

1	To learn the fundamentals of data models to conceptualize and depict a database system using ER diagram.
2	To discuss the implementation of Relational database using structured query language
3	To practice the procedural extensions such as Procedures, functions, triggers and cursors.
4	To develop an application using front end and back end tools.

Course Outcomes:

Upon completion of the course, students shall have ability to

C405.1	Design an ER diagram for real world applications	[AP]
C405.2	Interpret and query a database using SQL-DDL, DML Commands	[AP]
C405.3	Employ PL/SQL blocks such as stored procedures, functions, triggers and cursors	[AP]
C405.4	Implement and evaluate a real database application using front end and back end.	[AP]
C405.5	Create a document database using NoSQL	[AP]

Course Contents:

Lab Exercises

1. Conceptual Database design using E-R DIAGRAM
2. Implementation of SQL commands DDL, DML, DCL and TCL
3. Queries to demonstrate implementation of Integrity Constraints
4. Practice of Inbuilt functions
5. Implementation of Simple queries
6. Implementation of Nested Queries
7. Implementation of Join and Set operators
8. Implementation of virtual tables using Views
9. Practice of named PL/SQLblocks (Procedure, Function)
10. Implementation of Triggers using PL/SQL
11. Implementation of cursors using PL/SQL
12. Application Development using front end tools and database connectivity

13. Study of MongoDB 14. Document Database creation using MongoDB 15. Study of Cloud Storage	
Total Hours:	**45**
Text Books:	
1	Gupta G K, “Database Management Systems”, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2	Peter rob, Carlos Coronel, “Database Systems – Design, Implementation and Management”, 9th Edition, Thomson Learning, 2009.
3	Michael McLaughlin,” Oracle Database 12c PL/SQL Programming”, Tata McGraw Hill Education Private Limited, New Delhi, 2014.
4	Gaurav Vaish, “Getting Started with NoSQL”, PacktPublishing, March 2013
Reference Books:	
1.	Jonathan Gennick, SQL Pocket Guide, 3rd Edition, O'Reilly Media, Inc.,Nov 2010
2.	RamezElmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Fourth Edition , Pearson/ Addision wesley, 2007.
3.	Rosenzweig ,”Oracle PL/SQL”, Pearson Education India; 5th edition (1 January 2015)
Web References:	
1.	www.tutorialspoint.com/dbms/
2.	https://www.javatpoint.com/dbms-tutorial
3.	https://www.w3schools.com/sql/
Online Resources:	
1.	https://nptel.ac.in/courses/106/106/106106093/
2.	https://www.coursera.org/learn/intro-sql

Assessment Methods & Levels (based on Blooms’ Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom’s Level	**Rubric based Continuous Assessment [60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	20	20
Understand	20	20

Apply	60	60
Analyze	-	-
Evaluate	-	-
Create	-	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C405.1	3	3	3		3			2	3	2		3	2	3	3
C405.2	3	3	3		3			2	3	2		3	2	3	3
C405.3	3	3	3		3			2	3	2		3	2	3	3
C405.4	3	3	3		3			2	3	2		3	2	3	3
C405.5	3	3	3		3			2	3	2		3	2	3	3

20AD401	DATA WAREHOUSING AND MINING	3/0/0/3

Nature of Course:	D (Theory application)
Pre requisites:	Nil

Course Objectives:

1	To know the Architecture of a Data Mining system.
2	To be familiar with the Data warehouse architecture and its Implementation.
3	To explore the various Mining techniques
4	To understand the various classification and clustering techniques
5	To analyze the cluster-based Methods.

Course Outcomes:

Upon completion of the course, students shall have ability to

C401.1	Understand the evolutionary path that has led to the purpose of adapting to Data Warehouse and Data Mining techniques in various domains	[U]
C401.2	Identify the need of Data Warehouse tools and techniques for designing and developing different types of databases	[AP]
C401.3	Measure the performance of any classification algorithm and Clustering	[AP]
C401.4	Comprehend the importance and role that Data Warehouse and Data Mining play in various fields	[U]
C401.5	Apply the knowledge on Clustering Methods and its applications using real time data	[AP]

Course Contents:

Introduction to Data Warehousing and Data Mining **15 Hours**

Data Warehousing Components –Building a Data warehouse – Data Warehouse Architecture, OLAP vs OLTP, OLAP operations - Data Warehouse v/s Data Mining, Data Mining Process, Data Mining Functionalities, Data Pre-processing – Descriptive Data Summarization, Data Cleaning, Integration and Transformation, Reduction.

Data Mining Concepts: **15 Hours**

Classification, Issues in Classification, Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms, Prediction – Prediction techniques, Linear and Non-Linear Regression. Association Rule Mining: Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis.

Clustering and its real time application: **15 Hours**

Categorization of Major Clustering Methods: Partitioning Methods, Hierarchical Methods, Density-Based

Methods, Grid-Based Methods, Outlier Detection. Applications of clustering -Pattern recognition, Finding similar users on Twitter, Analyzing the Stack Overflow data set.

Total Hours:45

Text Books:

1	ReemaThareja, “Data Warehousing”, Oxford University Press.
2	Jiawei Han, MichelineKamber and Jian Pei, “Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2012.
3	Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.

Reference Books:

1	W.H. Inmon, “Building the Data Warehouse”, John Wiley & Sons, Inc, 4th Edition, 2005
2	VikramPudi, P. RadhaKrishana “Data Mining”, Oxford University press
3	K.P. Soman, ShyamDiwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.

Web References:

1	https://examupdates.in/data-mining-lecture-notes/
2	http://www.miet.edu/course/wp-content/uploads/2019/05/dwdm-completed-notes.compressed.pdf
3	https://livebook.manning.com/book/mahout-in-action/chapter-12/82

Online Resources:

1	https://www.classcentral.com/subject/data-mining
2	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
3	https://www.coursera.org/specializations/data-mining

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C401.1	Understand	Quiz	5
C401.2	Apply	Assignment	10
C401.3, C401.5	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA - I [10 Marks]	CIA - II [10 Marks]	CIA - III [10 Marks]	
Remember	-	-	-	-
Understand	50	30	20	20
Apply	50	40	40	40
Analyze	-	30	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C401.1	1	2	1									2	2	2	1
C401.2	3	3	2									3	2	3	2
C401.3	3	3	2									2	3	3	3
C401.4	3	3	2									3	3	2	3
C401.5	2	3	3									2	3	2	3

20AD402	BIOLOGY FOR ENGINEERS	3 / 0 / 0 / 3

Nature of Course	D (Theory application)
Pre-Requisite	Nil

Course Objectives:

1	To familiarize the students with the basic organization of organisms and subsequent building to a living being
2	To impart knowledge on molecular biology and nervous systems
3	To provide adequate knowledge on immune system and cell signalling.
4.	To be familiar with the enzymes and their industrial applications

Course Outcomes:

Upon completion of the course, students shall have ability to:

C402.1	Describe biological cell structure and its functions	[U]
C402.2	Explain protein structure and its synthesis	[U]
C402.3	Discuss nervous system and Immune system	[U]
C402.4	Highlight the important functions of enzymes	[AP]
C402.5	Analyze the applications of enzymes in different industrial processes	[A]

Course Contents:

Basic cell biology: (15 hours)

Introduction: Methods of Science-Living Organisms: Cells and Cell theory, Cell Structure and Function, Genetic information, protein synthesis, and protein structure, Cell Metabolism-Homoeostasis- Cell growth, reproduction, and differentiation.

Biochemistry, Molecular biology, Nervous and Immune system:(15 hours)

Biological Diversity-Chemistry of life: chemical bonds-Biochemistry and Human Biology-Protein synthesis-Stem cells and Tissue engineering, Nervous system-Immune system- General principles of cell signaling

Enzymes and industrial applications (15 hours)

Enzymes: Biological catalysts, Proteases, Carbonic and hydrase, Restriction enzymes, and Nucleoside monophosphate kinases – Photosynthesis. **Industrial Applications:** Applications of Enzymes in Food processing industries, Pharmaceutical industries, textile processing and fabric finishing industries.

Total Hours:45

Text Books:

1.	S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, “Biology for Engineers,” Tata McGraw-Hill, New Delhi, 2012.
2	Wiley Editorial team,” Biology for Engineers: As per Latest AICTE Curriculum, Wiley Precise Text book Series, New Delhi- Jan 2018.

Reference Books:

1	Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, “Biochemistry,” W.H. Freeman and Co. Ltd., 6thEd., 2006.
2	Robert Weaver, “Molecular Biology,” MCGraw-Hill, 5thEdition, 2012.
3	Kenneth Murphy, “Janeway's Immunobiology,” Garland Science; 8th edition, 2011.
4	Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, “Principles of Neural Science, McGraw-Hill, 5th Edition, 2012.
5	Arthur T. Johnson,”Biology for Engineers”,CRC Press, Taylor and Francis, 2019

Web References:

1	https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/
2	https://www.coursera.org/lecture/industrial-biotech/biocatalysis-and-enzymatic-processes-qruF0

Online Resources:

1	https://nptel.ac.in/courses/121/106/121106008/
2	https://www.dbs.nus.edu.sg/research/research-focus/cell-molecular-and-developmental-biology/

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C402.1	Understand	Online Quiz	5
C402.2, C402.3	Understand	Case study	5
C402.4, C402.5	Apply	Group Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment (30)			End Semester Examination (50)
	CIA1	CIA2	CIA3	
Remember	50	50	20	30
Understand	50	50	40	40
Apply	-	-	40	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C402.1	3	3	3									2	2		
C402.2	3	3	3									2	2		
C402.3	3	3	3									2	2		
C402.4	3	3	3									2	2		
C402.5	3	3	3	3								3	3		

20AD403	INTRODUCTION TO COMPUTER NETWORKS	3 / 0 / 0 / 3

Nature of Course:	**C (Theory Concept)**
Pre-Requisite	**Nil**

Course Objectives:

1.	To explain networks, topologies and the key concepts.
2.	To discuss the layered communication architectures and its functionalities.
3.	To demonstrate the concepts of error control, addressing and routing mechanisms.
4.	To identify the functions, protocols and communication between layers.
5.	To describe user-oriented services and advanced networking technologies.

Course Outcomes:

Upon completion of the course, students shall have ability to

C403.1	Describe the fundamentals of data communications, topologies and functions of layered models.	[U]
C403.2	Practice the error detection and correction methods and explain data link layer functionalities.	[AP]
C403.3	Examine the logical addressing schemes and routing strategies.	[A]
C403.4	Discuss the process-to-process delivery models and congestion control principles.	[U]
C403.5	Describe the services of application layer and emerging networking technologies.	[U]

Course Contents:

Overview of data communication, Networking and Transmission: 15 Hours

Introduction: Data Communications - Networks - The Internet - Protocols and standards -The OSI model - TCP/IP Protocol Suite. Data and Signals: Analog and Digital - Transmission Impairment – Performance. Digital Transmission: Line Coding Basics & schemes. Transmission media: Guided Media - Unguided Media. Switching: Circuit Switched Networks, Datagram Networks and Virtual-Circuit Networks.

Node-to-Node and Source-to-Destination Delivery: 15 Hours

Data link layer: Introduction - Error detection and correction (Parity, CRC & Hamming code) - Framing - Flow and Error Control Protocols: Noiseless Channels & Noisy Channels - Multiple Access Protocols – Ethernet: IEEE Standards, Standard Ethernet, Fast Ethernet, Gigabit Ethernet, Wi-Fi And Bluetooth. Network layer: Logical Addressing - IPv4, IPv6 Addresses and Packet Formats - Transition from IPv4 to

IPv6 - Protocols: Address Mapping, ICMP - Routing algorithms: Forwarding - Unicast routing protocols.

Process-to-Process Delivery and Services to Users: 15 Hours

Transport layer: Process to process delivery - UDP - TCP - Congestion control & Quality of service: Data Traffic - Congestion - Congestion Control - Quality of Service - Techniques to improve QoS - Socket Programming. Application layer: DNS - E-Mail - FTP - WWW - HTTP.

CASE STUDY - Software-Defined Networking (SDN), Datacenter Networks.

Total Hours:45

Text Books:

1.	Behrouz A. Forouzan, “Data communication and Networking”, 5th Edition, Tata McGraw-Hill, 2016.
2.	AS Tanenbaum, DJ Wetherall, “Computer Networks”, 6th Edition, Prentice-Hall, 2021.
3.	Thomas D. Nadeau and Ken Gray, “SDN: Software Defined Networks”, O’Reilly Media, Inc., 2013

Reference Books:

1.	Peterson & Davie, "Computer Networks, A Systems Approach", 3rd Edition, Harcourt, 2013
2.	William Stallings, “Data and Computer Communications”, 8th Edition, PHI, 2006
3.	Bertsekas and Gallagher “Data Networks, PHI, 2000
4.	JF Kurose, KW Ross, “Computer Networking: A Top-Down Approach”, 5th Edition, Addison-Wesley, 2009.
5.	Paul Goransson and Chuck Black ,”Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publications, 2014.
6.	Gary Lee, “Cloud Networking - Understanding Cloud-based Data Center Networks”,Elsevier, 2014

Web References:

1.	https://www.geeksforgeeks.org/computer-network-tutorials/
2.	https://www.javatpoint.com/computer-network-tutorial

Online Resources:

1.	http://nptel.ac.in/courses/106105082/
2.	https://nptel.ac.in/courses/106105183/
3.	https://www.udacity.com/course/computer-networking--ud436

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks

C403.1	Understand	Online Quiz	**4**
C403.2	Apply	Assignment	**4**
C403.3	Analyse	Case Study	**4**
C403.4	Understand	Class Presentation	**4**
C403.5	Understand	Class Presentation	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**End Semester Examination [50 Marks]**
	CIA1 [10 Marks]	**CIA2 [10 Marks]**	**CIA3 [10 Marks]**	
Remember	20	20	20	20
Understand	50	30	40	40
Apply	30	30	30	30
Analyse	-	20	10	10
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C403.1	1	1	2									2	2	2	
C403.2	3	3	3	3	2							3	3	3	3
C403.3	3	3	3	3	2							3	3	3	2
C403.4	3	2	2	2	2							2	3	1	
C403.5	3	2	3	2	2							2	3	2	

20AD404	MACHINE LEARNING	3 / 0 / 0 / 3

Nature of Course:	G - Theory analytical
Pre requisites:	Nil

Course Objectives:

1	To describe the basic concepts and techniques of Machine Learning.
2	To recognize the Supervised and Unsupervised learning techniques.
3	To explore the various probability-based learning techniques
4	To identify the graphical models of machine learning algorithms
5	To analyze the decision tree and artificial neural networks.

Course Outcomes:

Upon completion of the course, students shall have ability to

C404.1	Distinguish between, supervised, unsupervised and semi-supervised learning	[U]
C404.2	Interpret hypothesis space search and back propagation algorithm	[AP]
C404.3	Apply the appropriate machine learning strategy for any given problem	[AP]
C404.4	Design systems that uses the appropriate graph models of machine learning	[A]
C404.5	Modify existing machine learning algorithms to improve classification efficiency	[A]

Course Contents:

Introduction and Concept Learning: 15Hours

Introduction: Well-posed learning problems, designing a learning system, perspectives and issues in machine learning, Supervised and unsupervised learning, Linear Regression, Learning Associations, concept learning and general to specific ordering: A concept learning task, concept learning as search, FIND-S: Finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, Remarks, Inductive Bias.

Decision Tree and Artificial Neural Networks: 15Hours

Decision tree learning: decision tree representation, appropriate problems for decision tree learning, the algorithm, hypothesis space search, Support Vector Machines, Ensemble learning, boosting/bagging, Artificial neural networks: neural network representation, problems, perceptron, multilayer networks and back propagation algorithm, an illustrative example: face recognition, Hand-writing with recurrent neural networks, Self-organizing feature map.

Bayesian And Reinforcement Learning: 15Hours

Bayesian Learning: Bayes theorem, concept learning, naive bayes classifier: learning to classify text, EM algorithm, Instance based learning: k-nearest neighbour learning, case-based reasoning, Genetic algorithms: an illustrative example, genetic programming, Reinforcement learning: the learning task, Q learning, non-deterministic rewards and actions.

Total Hours:45

Text Books:

1	Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 2017.
2	Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Reference Books:

1	Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition”, Cambridge University Press, 2012.
2	Jason Bell, “Machine learning –Hands on for Developers and Technical Professionals”, First Edition, Wiley, 2014
3	Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)”, Third Edition, MIT Press, 2014

Web References:

1	https://www.geeksforgeeks.org/machine-learning/
2	https://machinelearningmastery.com/types-of-learning-in-machine-learning/

Online Resources:

1	https://www.coursera.org/learn/machine-learning
2	https://nptel.ac.in/courses/106/106/106106139/
3	https://www.timberlake.co.uk/machinelearning

Assessment Methods & Levels (based on Blooms Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C404.1	Understand	Quiz	5
C404.2	Apply	Assignment	5
C404.3	Apply	Tutorial	5

C404.4, C404.5	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA - I [10 Marks]	CIA - II [10 Marks]	CIA - III [10 Marks]	
Remember	-	-	-	-
Understand	50	30	20	20
Apply	50	40	40	40
Analyze	-	30	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C404.1	1	1	1									2	1	2	1
C404.2	3	3	2	3								3	2	3	
C404.3	3	3	2	3	3							2	3	3	
C404.4	3	3	2	2	3							3	3	2	3
C404.5	2	1	2		2							1	3	2	2

20AD405	FUNDAMENTALS OF SOFTWARE ENGINEERING	3 / 0 / 0 / 3
Nature of Course	H (Theory Technology)	
Pre requisites	Nil	

Course Objectives:

1.	To understand the phases, concepts of requirements engineering and Analysis Modeling
2.	Carry out all stages of an agile software process in a team, to produce working software.
3.	Ability to understand and apply Scrum framework.
4.	Use test driven development (TDD) to ensure software quality.

Course Outcomes

Upon completion of the course, students shall have ability to

C405.1	Apply current theories, models, and techniques that provide a basis for the software lifecycle	[AP]
C405.2	Apply software engineering principles and techniques in product design and development	[AP]
C405.3	Demonstrate and develop the working model facilitated by unit tests using Test Driven Development.	[A]
C405.4	Apply design principles and refactoring to achieve Agility.	[AP]
C405.5	Illustrate automated build tools, version control and continuous integration using JIRA and Jenkins.	[U]
C405.6	Apply Risk based testing activities within an Agile project.	[AP]

Course Contents:

Software Process and Requirements Analysis: 15 Hours

Introduction: Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models- Waterfall model, Incremental model, Iterative model, RAD model. Software **Requirements:** Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation

Introduction to Agile: 15 Hours

Fundamentals of Agile: The Genesis of Agile, Introduction and background, Agile Manifesto and

Principles, Overview of Scrum, Extreme Programming, Feature Driven development, Lean Software Development, Design and development practices in Agile projects, Pair Programming, Agile Tools. **Agile Scrum Framework:** Introduction to Scrum, Project phases, Agile Estimation, Planning game, Product backlog, Sprint backlog, Iteration planning, User story definition, Characteristics and content of user stories, Acceptance tests and Verifying stories, Project velocity, Burn down chart, Sprint Scrum Team.

Agile Software Design, Development and Testing: **15 Hours**

Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control. **Testing:** The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories - acceptance tests and scenarios, Behavior-driven development (BDD), Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester.

Case Study: DevOps, SAFe, Norwegian Scrum Project

Total Hours	**45 hours**

Text Books:

1.	Roger S. Pressman, “Software Engineering – A Practitioner’s Approach”, Seventh Edition, Mc Graw-Hill International Edition, 2010
2.	Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, Pearson Education, 2nd Edition, 2014.
3.	Janet Gregory, Lisa Crispin, “Agile Testing Condensed: A Brief Introduction”, Addison Wesley, 2019.

Reference Books:

1.	Robert C. Martin, “Agile Software Development, Principles, Patterns and Practices”, Prentice Hall, 2nd Edition, 2014.
2.	Alistair Cockburn, “Agile Software Development: The Cooperative Game (Agile Software Development Series)” 2nd Edition, Kindle Edition.
3.	Mike Cohn, “User Stories Applied: For Agile Software”, Addison Wesley, 2nd Edition, 2016.

Web References:	
1.	https://www.coursera.org/specializations/agile-development
2.	https://www.edx.org/learn/agile
3.	https://nptel.ac.in/courses/106/105/106105182/

Online Resources:	
1.	http://www.agilenutshell.com/
2.	https://www.atlassian.com/agile/scrum
3.	https://www.youtube.com/user/AgileMikeCohn
4.	https://www.youtube.com/channel/UCL1yMVRMh3vxitPiVaXfkoA

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C405.1, C405.2	Apply	Online Quiz	**5**
C405.3	Analyse	Assignment	**5**
C405.4, C405.6	Apply	Case Study	**5**
C405.5	Understand	Class Presentation	**5**

Summative assessment based on Continuous and End Semester Examination

Revised Bloom's Level	Continuous Assessment			End Semester Examination (Theory) [50 marks]
	Theory			
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	25	20	30	30
Understand	25	30	30	30
Apply	50	50	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C405.1	2	2	2	1								2	1	1	1
C405.2	3	3	3	3	2							2	3	2	2
C405.3	3	3	3	3								2	3	3	2
C405.4	3	3	3	3	3							2	3	3	2
C405.5	3	2	3	3	3							1	3	3	2
C405.6	1	2	1	1								2	1	2	1

20MA404	RANDOM VARIABLES AND STATISTICS	2 / 1 / 2 / 4

Nature of Course	J (Problem analytical)
Pre requisites	Concepts of basic differentiation and Integration

Course Objectives:

1	To study the basic probability concepts
2	To understand and have a well – founded knowledge of standard distributions which can be used to describe real life phenomena
3	To acquire skills in handling situations involving more than one random variable
4	To learn the concept of testing hypothesis using statistical analysis
5	To apply the Analysis of variance classifications in one way and two way

Course Outcomes:

Upon completion of the course, students shall have ability to

C404.1	Recall the concepts of basic probability	[R]
C404.2	Understand how to handle situations involving random variable	[U]
C404.3	Applying different pattern of standard distributions in real life problems.	[AP]
C404.4	Use distribution in cluster analysis of similar binary variables	[AP]
C404.5	Derive the logic and attain the knowledge of hypothesis testing.	[AP]
C404.6	Apply the analytical comparisons using ANOVA.	[AP]

Course Contents:

Module 1: Probability and Random Variables **15 hrs**

Probability: Probability concepts - Addition and Multiplication law of probability – Conditional probability - Total probability theorem - Bayes theorem – **Random Variables:** One dimensional random variable - Discrete random variables -Probability mass function - Continuous random variables - Probability density function- Moment generating Function.

Module 2: Standard distributions **15 hrs**

Standard distributions: Discrete distributions - Binomial – Poisson – Geometric – Continuous distributions - Uniform – Exponential - Normal distributions –**Two dimensional random variables**: Joint distributions - Marginal and conditional distributions – Covariance – Correlation- Regression-Applications

of two-dimensional random variables in Machine learning.

Module 3: Statistics **15 hrs**

Mean, median, mode and standard deviation for raw, discrete and continuous data - Testing of Hypothesis: Large sample - Z test -Test of significance - Proportions - Small sample test – t test and F test for single mean – difference of means and variance - Chi-square test for goodness of fit and independence of attributes. **Analysis of variance**: One way and two way classifications.

Course Outcomes: (Laboratory)

Upon the completion of the course, students shall have ability to

C404.1	Understand the use of R for Big Data analytics.
C404.2	Demonstrate the Data frame from vectors.
C404.3	Analyze and interpret results from correlation and regression.
C404.4	Understand the basic concepts of distributions and find an appropriate distribution for analyzing data specific to an experiment.
C404.5	Explore the types of plots and to represent with the help of functions.
C404.6	Understand to perform the extensive hypothesis tests for one and two samples.

Laboratory Component:

S.No	List of Experiments	CO Mapping	RBT
1.	To perform importing and exporting data using suitable Mathematical software.	C404.1	[AP]
2.	To perform with Vectors and Matrices using suitable Mathematical software.	C404.2	[AP]
3.	To plot Data frames using suitable Mathematical software.	C404.2	[AP]
4.	To Compute Summary Statistics, plotting and visualizing data using Tabulation and Graphical Representations using suitable Mathematical software.	C404.5	[AP]
5.	To solve correlation and simple linear regression model to real dataset using suitable Mathematical software.	C404.3	[AP]
6.	To Fit the following probability distribution: Binomial distribution using suitable Mathematical software.	C404.4	[AP]

7.	To Fit the following probability distribution: Poisson distribution using suitable Mathematical software.	C404.4	[AP]
8.	To Fit the following probability distribution: Normal distribution using suitable Mathematical software.	C404.4	[AP]
9.	To test of hypothesis for One sample mean and proportion from real-time problems using suitable Mathematical software.	C404.6	[AP]
10.	To test of hypothesis for Two sample mean and proportion from real time problems using suitable Mathematical software.	C404.6	[AP]
11.	To perform the t test for independent and dependent samples using suitable Mathematical software.	C404.6	[AP]
12.	To perform Chi-square test for goodness of fit test and Contingency test to real dataset using suitable Mathematical software.	C404.6	[AP]
			Total Hours: 60 Hours

Text Books:

1	Gupta, S.C., &Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 2000,Reprint 2014.
2	Peebles Jr. P.Z., —Probability Random Variables and Random Signal Principles,Tata McGraw-Hill Pubishers, Fourth Edition, New Delhi, 2016(Chapters 6, 7 and 8).
3	Palaniammal, S., —Probability and Random Processes, Prentice hall of India, New Delhi, 2014.

Reference Books:

1	Ross, S., —A First Course in Probability, Ninth edition, Pearson Education, Delhi, 2014.
2	Henry Stark and John W. Woods —Probability and Random Processes with Applications to Signal Processing, Third Edition, 2001.
3	Richard A. Johnson, Irwin Miller, John Freund,"Miller & Freund's Probability and Statistics for Engineers", Ninth edition,2016.
4	R for Everyone: Advanced Analytics and Graphics, Jared P. Lander.
5	Hands-on Programming with R, Garrett Grolemund.

Web References:

1	http://nptel.ac.in/courses/111104079/
2	http://nptel.ac.in/video.php/subjectId=117105085

3	http://nptel.ac.in/syllabus/111105041/
4	http://freevideolectures.com/Course/3028/Econometric-Modelling/22#
5	http://nptel.ac.in/courses/111104079/

Online Resources:

1	www.edx.org/Probability
2	https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/
3	https://onlinecourses.nptel.ac.in/noc15_ec07/

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical& Project	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	Rubric based CIA [30 Marks]	
Remember	20	20	20	20	20
Understand	30	30	30	30	30
Apply	50	50	50	50	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Articulation Matrix (Theory)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C404.1	1	1	-	-	-	-	-	-	-	-	-	-	1	-	-
C404.2	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
C404.3	3	3	-	-	-	-	-	-	-	-	-	-		-	-
C404.4	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
C404.5	3	3	-	-	-	-	-	-	-	-	-	-		-	-
C404.6	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-

Course Articulation Matrix (Laboratory)

CO	PO 1	PO	PO 3	PO	PO	PO 6	PO	PO	PO	PO	PO	PO	PSO	PSO	PSO

		2		**4**	**5**		**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C404.1	1	1	-	-	3	-	-	-	-	-	-	-	1	-	-
C404.2	2	2	-	-	3	-	-	-	-	-	-	-	1	-	-
C404.3	3	3	-	-	3	-	-	-	-	-	-	-		-	-
C404.4	3	3	-	-	3	-	-	-	-	-	-	-	1	-	-
C404.5	3	3	-	-	3	-	-	-	-	-	-	-		-	-
C404.6	3	3	-	-	3	-	-	-	-	-	-	-	1	-	-

20AD406	NETWORKS LABORATORY	0/0/3/1.5
Nature of Course	M (Practical Application)	
Pre requisites	Nil	

Course Objectives:

1	To learn and use network commands.
2	To demonstrate socket programming using java.
3	To implement and analyze various networking protocols.
4	To have Hands-on Experience on networking tool.

Course Outcomes:

Upon completion of the course, students shall have ability to

C406.1	Illustrate various network administration commands.	[AP]
C406.2	Implement various protocols using TCP and UDP sockets in java.	[AP]
C406.3	Analyze the performance of the protocols and algorithms in different Layers.	[A]
C406.4	Investigate the network performance using tool and apply the Solutions to the problems incurred.	[AP]

List of Experiments:

1. Study of system administration and network administration commands.
2. Implementation of echo client and echo server.
3. Implementation of bit stuffing and hamming code algorithms.
4. Implementation of sliding window protocols.
5. Implementation of Subnetting.
6. Implementation of Address Resolution Protocol to get the MAC or Physical address of the system.
7. Implementation of Remote Command Execution.
8. Implementation of Domain name system.
9. Implementation of File Transfer Protocol.
10. Study of Wire Shark Tool.

Total Hours 45

Text Books:

1	Kenneth L. Calvert, Michael J. Donahoo, “TCP/IP Sockets in Java: Practical Guide for Programmers”, Imprint: Morgan Kaufmann 2008.
2	Elliotte Rusty Harold, “Java Network Programming”, Developing Networked Applications”,

	O'Reilly Media, 2013.

Reference Books:

1.	Craig Hunt, “TCP/IP Network Administration”, O'Reilly Media, 3rd Edition 2002.
2.	Esmond Pitt, “Fundamental Networking in Java”, 3rd Edition, Springer.
3.	James F. Kurose, Keith W. Ross, “Computer Networking: A Top-down Approach”, Pearson Education, Limited, 6th Edition, 2012.

Web References:

1	https://www.geeksforgeeks.org/socket-programming-in-java/
2	https://www.javatpoint.com/java-networking

Online Resources:

1	http://nptel.ac.in/courses/106105082/
2	https://nptel.ac.in/courses/106105183/
3	https://www.udacity.com/course/computer-networking--ud436

Assessment Methods & Levels (based on BloomsTaxonomy)

Summative assessment based on Continuous and End Semester Examination

Blooms Level’s	Rubric based Continuous Assessment [60 marks] (in%)	End Semester Examination [40 marks] (in %)
Remember	-	-
Understand	20	20
Apply	60	60
Analyze	20	20
Evaluate	-	-
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C406.1	3	3	2	2	3			3	3	3		1	3	2	3
C406.2	2	3	3	2	3			3	2	3		1	3	3	2

C406.3	3	3	2	2	3			3	3	3		1	2	2	3
C406.4	2	3	3	2	3			3	3	3		1	3	2	3

20AD407	MACHINE LEARNING LABORATORY	0 / 0 / 3 / 1.5

Nature of Course	M (Practical Application)
Pre requisites	Machine Learning

Course Objectives:

1	Finding the most specific hypothesis based on a given set of training data
2	Interpret the training data from a .CSV file
3	Understand built-in Java classes/API to write the program
4	Analyze the data sets in implementing the machine learning algorithms

Course Outcomes:

Upon completion of the course, students shall have ability to

C407.1	Understand the implementation procedures for the machine learning algorithms.	[AP]
C407.2	Design Java / Python programs for various learning algorithms.	[A]
C407.3	Apply appropriate data sets to the Machine Learning algorithms.	[AP]
C407.4	Identify and apply Machine Learning algorithms to solve real world problems.	[A]
C407.5	Apply FIND-S, ID3, back propagation, k-means algorithm	[AP]

List of Experiments:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program.

	Calculate the accuracy, precision, and recall for your data set
7	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API
8	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem
10	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
	Total Hours **45**

Text Books:

1	Tom M Mitchell, “Machine Learning”, First Edition, McGraw Hill Education, 2017.
2	Stephen Marsland, “Machine Learning - An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Reference Books:

1.	Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition”, Cambridge University Press, 2012.
2.	Jason Bell, “Machine learning –Hands on for Developers and Technical Professionals”, First Edition, Wiley, 2014
3.	Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)”, Third Edition, MIT Press, 2014

Web References:

1	https://www.geeksforgeeks.org/machine-learning/
2	https://machinelearningmastery.com/types-of-learning-in-machine-learning/

Online Resources:

1	https://www.coursera.org/learn/machine-learning

2	https://nptel.ac.in/courses/106/106/106106139/
3	https://www.timberlake.co.uk/machinelearning

Assessment Methods & Levels (based on BloomsTaxonomy)

Summative assessment based on Continuous and End Semester Examination

Blooms Level's	Rubric based Continuous Assessment [60 marks] (in%)	End Semester Examination [40 marks] (in %)
Remember	-	-
Understand	20	20
Apply	60	60
Analyze	20	20
Evaluate	-	-
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C407.1	3	3	2					3	3	3		3	3	3	3
C407.2	3	3	2					3	2	3		3	3	2	3
C407.3	3	3	2					3	3	3		3	3	3	3
C407.4	3	3	2					3	3	3		3	3	3	3
C407.5	2	3	1					2	3	2		3	3	3	2

20AD501	DATA SCIENCE USING R	3/0/0/3

Nature of Course	F (Theory Programming)
Prerequisites	Python for Data Science

Course Objectives:

1	Apply quantitative modeling and data analysis techniques to the solution of real-world business problems.
2	To exercise the fundamentals of statistical analysis in the R environment.
3	To analyze data for the purpose of exploration using Descriptive and Inferential Statistics.
4	To use descriptive, predictive and prescriptive analytics to drive growth.
5	To extract valuable information for use in strategic decision making, product development, trend analysis, and forecasting.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C501.1	Understand the different data types in R.	[U]
C501.2	Apply functions in R to perform data analytics	[AP]
C501.3	Resize data from long to wide and back to support different analysis.	[AP]
C501.4	Identify and deal with missing data.	[A]
C501.5	Understand how to link data, statistical methods, and actionable questions.	[U]
C501.6	Predict/Score new data using models.	[AP]

Course Contents:

MODULE I: INTRODUCTION TO R **15 Hours**

Overview of R Language - Data Types - Variable - Operators - Decision Making - Loop control - Array - String - Function - Vector - Lists - Matrices - Factors - Data Frames - Packages - Data and File Management - Charts & Graphs.

MODULE II: DATA ANALYSIS AND VISUALIZATION **15 Hours**

Introduction to data science - Data visualization - A grammar for graphics - Data Preprocessing - Data wrangling on one table - Data wrangling on multiple tables - Tidy data – Iteration.

MODULE III: STATISTICS AND MODELING **15 Hours**

Statistical foundations - Predictive modeling - Supervised learning - Unsupervised learning. **Case study:** Fit a series of supervised learning models to predict arrival delays for flights from New York to SFO using the nycflights13 package.

Total Hours:	**45**

Text Books:

1	Benjamin S. Baumer, Daniel T. Kaplan, and Nicholas J. Horton, “Modern Data Science with R” 2nd edition, CRC Press, July 28, 2021.
2	Hadley Wickham & Garrett Grolemund "R for Data Science - Import, Tidy, Transform, Visualize, and Model Data", O'Reilly , 1st edition, December 2016.
3	Tilman M. Davies, "The Book of R", No Starch Press, 1st edition, July 16 2016.

Reference Books:

1	Joel Grus, "Data Science from Scratch", O'Reilly, 1st edition, April 2015.
2	Norman Matloff, "The Art of R Programming", No Starch Press, 1st edition, 2011.
3	Garrett Grolemund, "Hands on programming with R", O'Reilly , 1st edition, July 22 2014.

Web References:

1	https://nptel.ac.in/courses/106/106/106106179/
2	https://www.atnyla.com/syllabus/r-programming-language/7

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C501.1, C501.2	AP	Quiz	5
C501.3, C501.4	A	Assignment	5
C501.5, C501.6	AP	Developing a Model	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	20	20	20	20
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C501.1	1	1	3	3	3							2	3	3	3
C501.2	1	2	3	3	3	1						2	3	3	3
C501.3	2	2	3	3	2							3	3	3	3
C501.4	2	1	3	3	3							2	3	3	3
C501.5	2	1	2	3	2	1						3	3	3	3
C501.6	3	3	3	3	2				2	2		3	3	3	3

20AD502	FUNDAMENTALS OF SIGNALS AND SYSTEMS	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	DICRETE TRANSFORMS AND FOURIER ANALYSIS	
Course Objectives:		
1	Understand the basic properties of signals and systems.	
2	Understanding signals and systems in terms of both time and frequency domains.	
3	Utilize the Laplace transform method to solve continuous, linear, time-invariant systems and to obtain transfer functions.	
4	Developing Expertise in time domain and frequency domain approaches to the analysis of Discrete time signals and system in Fourier and Z-transform domain.	
5	Development of the mathematical skills to solve problems involving convolution and filtering.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C502.1	Acquire the knowledge of signal, system and its classifications	[R]
C502.2	Derive mathematical model of the systems and signals for the applications	[U]
C502.3	Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier and Laplace	[AN]
C502.4	Explore their acquired knowledge on recalling the applications of transformation techniques	[AP]
C502.5	Analyze the response of LTI system using convolution integral and LSI system using convolution.	[AN]
C502.6	Apply Fourier transform and Z-transform for the analysis of discrete-time signals and systems.	[AP]
Course Contents:		
MODULE I CLASSIFICATION OF SIGNALS AND SYSTEMS: **15 Hours** Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ Classification of signals — Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals — Classification of systems- CT systems and DT systems- — Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable. **MODULE II ANALYSIS OF CONTINUOUS TIME SIGNALS: 15 Hours** Fourier Transform — properties- Laplace Transforms and properties - system representation using differential equations – System Analysis using Laplace transform and Fourier transform -–Impulse response and step response –Convolution integral. **ANALYSIS OF DISCRETE TIME SIGNALS 15 Hours** Discrete Time Fourier Transform (DTFT) and its properties – System representation using difference equations – Relationship between Z-transform and DTFT- System Analysis using Z-transform and DTFT – stability – impulse response and step response – convolution sum.		
	Total Hours:	**45**
Text Books:		
1	Allan V. Oppenheim et al," Signals and Systems", Prentice Hall of India, 2/E, 2015	
2	Ramakrishna Rao P, "Signals and Systems", McGraw Hill Education, New Delhi, 2/E, 2013.	
3	Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2/E ,2011	
Reference Books:		
1	J. Roberts, "Fundamentals of Signals and Systems", Tata McGraw Hill, 2007.	

2	B. P. Lathi, “Signal Processing and Linear Systems”, Oxford University Press, 1998.
3	R.F. Ziemer, W.H. Tranter and D.R. Fannin, “Signals and Systems – Continuous and Discrete”, Prentice Hall, 4/E, 1998.
Web References:	
1	http://www.nptelvideos.in/2012/12/signals-and-system.html
2	http://freevideolectures.com/Course/3177/Signals-and-Systems
Online Resources:	
1	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
2	https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-2

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C502.1	Remember	Quiz	4
C502.2	Analyze	Assignment	4
C502.3	Analyze	Problem Solving	2
C502.4	Analyze	Group Assignment	4
C502.5	Apply	Problem Solving	4
C502.6	Understand	Assignment	2

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	10	10	10
Understand	40	10	40	40
Apply	20	40	30	30
Analyse	20	40	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C502.1	2	2	3	3	1		1				1	2	2	1	2
C502.2	3	3	3	3	1		1				1	2	2	1	2
C502.3	3	3	3	3	1		1				1	2	2	1	2
C502.4	3	3	3	3	1		1				1	2	2	1	3
C502.5	3	3	3	3	1		1				1	3	2	1	2
C502.6	3	3	3	3	1		1				1	2	3	1	3

20AD503	CLOUD COMPUTING FUNDAMENTALS	3/0/3/4.5
Nature of Course	F (Theory Programming)	
Pre requisites	Computer Networks, Computer Architecture	
Course Objectives:		
1.	To understand the evolution of cloud from the existing technologies.	
2.	To have knowledge on the various issues and be familiar with the lead players in the cloud.	
3.	To team the necessary skills for design, develop and deploy services in creating an application in the cloud computing paradigm.	
4.	To expose the students to the frontier areas of Cloud Computing and to promote the spirit of entrepreneurship in providing Cloud Service.	
5.	To identify the best suit architecture, infrastructure and delivery models of Cloud Computing for a business scenario.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C503.1	Demonstrate the broad perspective of cloud architecture and model.	[U]
C503.2	Interpret the business scenario to provide the appropriate cloud computing solutions and recommendations.	[U]
C503.3	Configure a private cloud to enable and improve collaborative and small-scale business environments.	[AP]
C503.4	Experiment and use a generic cloud environment that can be used as a private cloud.	[AP]
C503.5	Apply large data sets in a parallel environment.	[AP]
C503.6	Design Cloud security architectures that assure secure isolation of compute, network and storage infrastructures, comprehensive data protection, end-to-end identity and access management.	[AP]

Course Contents:

INTRODUCTION TO CLOUD COMPUTING **15 Hours**

Introduction to Cloud Computing - Evolution of Cloud Computing - Introduction to Grid, Parallel, Utility, Cluster and Distributed Computing - System Models for Distributed and Cloud Computing, Technologies for Network based systems - Cloud Computing : Drivers, Challenges, Benefits, Characteristics - Layered Cloud Architecture Design - NIST Cloud Computing Reference Architecture - Public, Private, Community and Hybrid Clouds - IaaS - PaaS - SaaS - Architectural Design Challenges - Cloud ecosystem - Service management - Case studies - Anything as a service (XaaS).

CLOUD ENABLING TECHNOLOGIES **15 Hours**

Cloud-based Storage - Basics of Virtualization - Introduction to Various Hypervisors -Types of Virtualizations - Tools and Mechanisms - Virtualization of CPU – Memory - I/O Devices - Application - Databases - VM Migration - Virtual Clusters and Resource management - High Availability (HA)/Disaster Recovery (DR) - Virtualization Support and Disaster Recovery- Resource Provisioning - Cloud Based Analytics: Data Cube, Columnar storage, Data Lake.

WORKING WITH CLOUD ENABLED PLATFORM **15 Hours**

Public Cloud Services: AWS: Working with Amazon AWS - Amazon S3 - Working with Azure - Advanced Topics in Cloud Computing: Big data on AWS, Azure, and Google's cloud solutions. Security: Vulnerability Issues and Security Threats, Application - level Security, Data level security, and Virtual Machine level Security, IDS: host-based and network-based, Security-as-a-Service - Cloud Antivirus, Cloud Computing in Social Networking and E - Commerce. **Case Study:** Open Stack, Cloud based ML Solutions in Healthcare

Total Hours	**45 hrs**

Laboratory Component:

S. No	List of Experiments
1.	Study of Hosted Hypervisor and Bare Metal Hypervisor.
2.	Install a Virtualbox/VMware Workstation with different flavours of linux or windows S.
3.	Install a C compiler in the virtual machine created using virtual box and execute simple p.
4.	Implementation of Virtual Machine(S) and create a Virtual Datacenter.
5.	Configuration of Virtual Internetworking Components.
6.	Deployment of VMs in AWS.
7.	Integration of IoT Components in AWS/Azure.
8.	Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.
9.	Find a procedure to transfer the files from one virtual machine to another virtual machine Using VMWare.
10.	Install Google App Engine. Create a hello world app and other simple web applications using python/java.
Total Hours	**30 Hours**

Text Books:

1	Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2013.
2	Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata Mcgraw Hill, 2009.
3.	Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management and Security", CRC Press,1st Edition, 2017.

4.	Tim Mather, Subra Kumaraswamy, Shahed Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’Reilly, 2017.
Reference Books:	
1	George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", O’Reilly, 1st Edition, 2009.
2	Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, “Cloud Computing Principles Books and Paradigms”, Wiley, 2010.
3	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, “Distributed and Cloud Computing, From Parallel Processing to the Internet of Things”, Morgan Kaufmann Publishers, 2012.
Web References:	
1.	http://www.nptel.ac.in
2.	http://www.brainbell.com/tutors/A+/Hardware/Preventive_Maintenance.htm
3.	http://www.technologystudent.com/elec1/dig1.html
Online Resources:	
1.	https://www.edx.org/course/introduction-cloud-infrastructure-linuxfoundationx-lfs151-x
2.	https://www.aws.training/training.com

Tentative Assessment Methods & Levels (based on Revised Bloom’s Taxonomy

Summative assessment based on Continuous and End Semester Examination

Revised Bloom’s Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	Rubric based CIA [30 Marks]	
Remember	40	20	10	10	20
Understand	30	30	30	30	30
Apply	30	50	60	60	50
Analyse					
Evaluate					
Create					

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C503.1	3	3	3	3	3	1	1	2	2		1	2	3	2	2
C503.2	3	3	3	3	3	1	1	2	2		1	2	3	2	2
C503.3	3	3	3	3	3	1	1	2	2		1	2	3	2	2
C503.4	3	3	3	3	3	1	1	2	2		1	2	3	2	2
C503.5	3	3	3	3	3	1	1	2	2		1	3	3	2	2
C503.6	3	3	3	3	3	1	1	2	2		1	3	3	2	2

20AD504	DATA SCIENCE LABORATORY	0/0/3/1.5

Nature of Course	J (Problem analytical)
Prerequisites	Python for Data Science

Course Objectives:

1	To study data exploration techniques.
2	To learn different types of data and its visualization.
3	To Understand and practice analytical methods for solving real life problems.
4	To develop a deeper understanding of regression and classification models.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C504.1	Install and use R for simple programming tasks.	[U]
C504.2	Extend the functionality of R by using add-on packages.	[U]
C504.3	Extract data from files and other sources and perform various data manipulation tasks on them.	[AP]
C504.4	Visualize time series, proportions & associations.	[AP]
C504.5	Code statistical functions in R.	[AP]
C504.6	Create regression, classification models for data analysis.	[AP]

Course Contents:

1. Getting Used to R: Describing Data
2. Creating and displaying Data.
3. Creating and manipulating a List and an Array
4. Creating a Data Frame and Matrix-like Operations on a Data Frame
5. String Manipulations
6. Data transpose operations in R
7. Probability Distributions.
8. Basic Statistics in R
9. Visualizing Data - Tables, charts and plots
10. Creating models for prediction

Total Hours:	**45**

Text Books:

1	Andrie de Vries and Joris Meys, "R For Dummies" Wiley, 2012.
2	Rob Kabacoff, "R in Action", Manning Publications, August 2011.
3	Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics",Second Edition, Addison-Wesley Professional, 23 September 2013.

Reference Books:

1	Joel Grus, "Data Science from Scratch", O'Reilly, 1st edition, April 2015.
2	Norman Matloff, "The Art of R Programming", No Starch Press, 1st edition, 2011.
3	Garrett Grolemund, "Hand on programming with R", O'Reilly , 1st edition, July 22 2014.

Web References:

1	https://nptel.ac.in/courses/106/106/106106179/
2	https://www.atnyla.com/syllabus/r-programming-language/7

Online Resources:

1	https://www.youtube.com/watch?v=SWxoJqTqo08&list=PLjgj6kdf_snYBkIsWQYcYtUZiDpam7ygg

2	https://www.youtube.com/watch?v=7WRlYJFG7YI
3	https://www.datacamp.com/courses/free-introduction-to-r
4	https://www.geeksforgeeks.org/r-programming-language-introduction/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment (60)	End Semester Examination (40)
Remember	20	20
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	20	20
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C504.1		1	1	1	2								3	2	3
C504.2		1	1	1	2								3	2	3
C504.3	1	3	3	3	2								3	3	3
C504.4	1	3	3	3	3								3	3	3
C504.5		2	2	2	2								3	3	3
C504.6	1	3	3	3	3				1		1	2	3	3	3

20AD601	AI IN NATURAL LANGUAGE PROCESSING	3/0/03

Nature of Course	F (Theory Programming)
Pre-Requisite	Artificial Intelligence Principles and Techniques

Course Objectives:

1	To learn the fundamentals of natural language processing.
2	To understand human morphology process.
3	Recognize speech and parts with grammar.
4	To familiarize with concepts of parsing.
5	To apply statistical technique and create machine translation models.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C601.1	Understand the fundamentals of Natural Language processing.	[U]
C601.2	Realize semantics and pragmatics of English language for text processing.	[U]
C601.3	Perform POS tagging and select suitable language modeling.	[AP]
C601.4	Applying hidden markov and maximum Entropy model.	[A]
C601.5	Learn about machine translations techniques.	[U]
C601.6	Develop a Statistical Methods for Real World Applications.	[AP]

Course Contents:

MODULE I: INTRODUCTION **15 Hours**

Origin of NLP - knowledge in speech and language processing - Regular Expression - Basic Patterns - Disjunction, grouping, precedence - Finite State Automata - Words and Transducers: English Morphology - Finite state Transducers - Words and Sentence Tokenization - Detecting and Correcting Spelling Errors - Minimum Edit distance - Human Morphological Processing.

MODULE II: WORD LEVEL ANALYSIS **15 Hours**

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models - Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing.

MODULE III: MACHINE TRANSLATION **15 Hours**

Speech recognition architecture - Dialogue and Machine Translation - Dialogue Acts – Automatic, Plan inferential, Cue based Interpretation of Dialogue Acts. **Case Study:** Text Summarization in NLP.

Total Hours:	**45**

Text Books:

1	Daniel Jurafsky, James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech”, Pearson Publication, 2018.
2	James Allen, “Natural language Understanding”, 2e, Pearson Education, 2020.
2	Nitin Indurkhya and Fred J. Damerau, “Handbook of Natural Language Processing”, Second Edition, Chapman and Hall/CRC Press, 2010.

Reference Books:

1	Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, First Edition, OReilly Media, 2009.

Web References:

1	https://www.coursera.org/specializations/natural-language-processing
2	https://www.simplilearn.com/natural-language-processing-training-course

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks

C601.1, C601.2, C601.5	U	Quiz	5
C601.4	A	Assignment	5
C601.3, C601.6	AP	Developing a Model	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	20	20	20	20
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C601.1		1	3	3	3							1	3	3	3
C601.2	1	2	3	3	3	1						1	3	3	3
C601.3	2	2	3	3	2							1	3	3	3
C601.4	2	1	3	3	3							1	3	3	3
C601.5	2	1	2	3	2	1						1	3	3	3
C601.6	3	3	3	3	2				2	2		1	3	3	3

20AD602	DATA VISUALIZATION USING TABLEAU	3/0/3/4.5
Nature of Course	G (Theory Analytical)	
Pre requisites	Data Warehousing and Mining	
Course Objectives:		
1.	To perceive in-depth knowledge on how to represent data with visual analytics.	
2.	To equip the knowledge of visual encoding design choices in an interactive and spatial form.	
3.	To gain an insight into Data Visualization techniques and tools.	
4.	To explore business insights and achieve business goals in the right direction.	
5.	To provide insight and training on designing visualization dashboard on large scale data.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C602.1	To understand the need for data abstraction and task abstraction with different applications.	[U]
C602.2	Apply the various visual analytics techniques available for arranging the different types of data.	[A]
C602.3	Identify and apply appropriate data visualization techniques, given particular requirements imposed by the data.	[AP]
C602.4	Employ best practices in data visualization to develop visual representations of data.	[R]
C602.5	Apply the different exploratory data analysis techniques on the datasets using Tableau.	[AP]
C602.6	Create Visualizations and dashboards on Tableau.	[AP]

Course Contents:

Introduction: **(15 Hours)**

Purpose of visualization, Data Abstraction: Data Types, Dataset types, Attribute types, Semantics, preparing your Data, Survey Data, Compute descriptive Statistics, Explore the data visually, Design Standards: Chart Format, Color, Text and Labels Readability, Scales, data Integrity, chart Junk, data density, data richness, Attribution and Design Standard Checklist. Task Abstraction: Actions, Targets, Analyzing & Deriving – Example, Four levels for Validation, Marks and Channels, Analysis – Four levels of Validation.

Data Manipulation: **(15 Hours)**

Introduction, Data Indexing and selection, operating on data, handling missing data, Hierarchical Indexing, combining dataset, Aggregation and Grouping, Pivot tables, String operation Visualization with Matplotlib: Line plots, Scatter Plots, Visualizing Errors, Density and Contour plots, Histogram, Customizing Plot legends, Color bars, Test and Annotation, three-dimensional Plotting, visualization with sea born. **Visualization Techniques**: Arrange tables, Arrange Network and Trees, Map Color and other Channels, Manipulate Views, Facet, Reduce Items and Attributes: Filter, Aggregate, Time-Series Data visualization, Text data Visualization, Multivariate data visualization and case studies.

Data Visualization: **(15 Hours)**

Exploratory Data Analysis using Tableau Visualizations, Creating basic visualizations- Geographic map, Crosstab Report, Connecting to Data, Live Connection, Blend data sources, cross-database join, creating groups and hierarchies, Mapping – Filled Maps, Mapping options Heat Map and highlight table, Dashboard Development - Design Principles and Interactivity.

	Total Hours	**45 hours**
Laboratory Component:		
S. No	**List of Experiments**	
1.	Visualization of Spreadsheet Models.	
2.	Oracle Database Connectivity.	
3.	Visualization of Semi-Structured Data.	
4.	Introduction to Tableau and Aggregation Methods.	
5.	Visual Encodings and Basic Dashboards.	
6.	Interactive Plots.	
7.	Hierarchical and Topographical Data Visualizations.	
8.	Calendar Heat maps and Flow Data Visualizations.	
9.	Time Series Data Visualization.	
10.	Dashboards, Actions and Story Telling.	
	Total Hours	**30 hours**
Text Books:		
1.	Sosulski K, “Data Visualization made simple: Insights into Becoming Visual, New York: Routledge, 2018.	
2.	TamaraMunzner, “Visualization Analysis and Design”, December 2014.	
3.	Joshua N.Milligan “Learning Tableau 2019 Tools for Business Intelligence, data prep, and visual analytics”, Packt, 2019.	
Reference Books:		
1.	Few, Stephen, “Show me the numbers: Designing Tables and Graphs to Enlighten” 2nd Edition. Analytics Press Publishers June 2012	
2.	Mathew Ward, Georges Grinstein and Daniel Keim, “ Interactive Data Visualization Foundations, Techniques, Applications” , 2010	
3.	Ryan Sleeper “Practical Tableau: 100 Tips, Tutorials and Strategies”, O’REILLY, 2018, First Edition.	
Web References:		
1.	https://datavizproject.com/	
2.	https://app.rawgraphs.io/	
3.	https://www.datawrapper.de/	
4.	https://www.tableau.com/	
5.	https://marketing platform.google.com/about/data-studio/	
6.	https://www.tableau.com/resources	
Online Resources:		
1.	Tableau Desktop 10: Students should download and install the free version of tableau for class use here http://www.tableau.com/academics/students	
2.	https://learning.oreilly.com/library/view/visualization-analysis-and/9781466508910/	
3.	https://www.udacity.com/course/data-visualization-nanodegree--nd197	
4.	https://www.udemy.com/course/mastering-the-art-of-data-visualization-2020/	

5.	https://www.datacamp.com/courses/data-visualization-for-everyone

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy					
Summative assessment based on Continuous and End Semester Examination					
Revised Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	**Rubric based CIA [30 Marks]**	
Remember	40	20	30	30	30
Understand	40	30	30	20	30
Apply	20	50	40	30	40
Analyse	-	-	-	20	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C602.1	2	3	1		1								1	2	2
C602.2	1	2	2		2								2	1	1
C602.3	3	3	3	3	3								3	3	1
C602.4	1	1	2		1								1	1	1
C602.5	2	1	2	2	1								2	1	2
C602.6		2	2		2								1	1	1

20AD603	IOT DESIGN AND APPLICATIONS	3/0/2/4
Nature of Course	D (Theory Application)	
Pre requisites	Nil	

Course Objectives:

1.	To understand the fundamentals of IoT, basic design and process modelling.
2.	To understand various IoT protocols like COAP, MQTT etc.
3.	To build simple and low cost IoT applications using any open-source software tools.
4.	To understand the design constraints of real world IoT applications and to apply the concept of Internet of Things in real world scenarios.

Course Outcomes

Upon completion of the course, students shall have ability to

C603.1	Infer the fundamental knowledge on Internet of Things.	[U]
C603.2	Build IoT systems using Raspberry Pi, Arduino, Node MCU on Embedded Platform.	[AP]
C603.3	Relate the market perspectives on Internet of Things.	[U]
C603.4	Examine the application of IoT in Industrial Automation and identify the Real-World Design Constraints.	[A]
C603.5	Demonstrate the integration of next generation technologies with IoT.	[U]
C603.6	Examine IoT applications in different domains and analyze their performance	[A]

Course Contents:

FUNDAMENTALS AND PROTOCOLS OF IOT **15 Hours**

Introduction to IoT – Evolution of IoT – Characteristics – IoT Enabling Technologies – IoT Architecture - Functional Blocks of IoT – IoT Protocols – HTTP, MQTT, CoAP, WebSockets, XMPP, IPv6 Low Power Communications: 6LoWPAN, Bluetooth Low Energy, Zigbee, IEEE 802.15.4,WiFi – IoT Communication Models – IoT Communication APIs – IoT Levels – IoE vs IoT vs M2M – SDN and NFV for IoT - Domain Specific IoT - IoT Challenges.

IOT DESIGN AND SYSTEM HARDWARE **15 Hours**

Sensors & Actuators - IoT Design Methodology **Arduino:** Physical Design – Interfaces – Arduino IDE – Arduino Programming with examples: Digital IO – Analog IO – Serial Communication – Condition and Looping statements – Programming using ESP8266 Node MCU. **Raspberry Pi:** Physical Design – Interfaces – Raspberry Pi programming using Python with examples – Python Packages for IoT.

CLOUD FOR IOT WITH REAL TIME APPLICATIONS **15 Hours**

Types of Cloud - IoT with Cloud challenges - Selection of cloud for IoT applications - Fog computing for IoT - Edge computing for IoT – IoT Data Lake – Role of Machine Learning - IoT Security. **Case studies:** AWS / ThingSpeak / AZURE IoT Hub / ThingsBoard / Adafruit IO

Total Hours	**45**

Laboratory Component:

S. No	List of Experiments
1.	Study and Configuration of Arduino kit / Node MCU / Raspberry PI.
2.	Basic Programming using Arduino / Raspberry PI: a. LED and Switch Interface b. Analog & Digital Sensor Interface c. Serial Communication

	d. Local display of sensor data using LCD e. Display of Sensor values in Mobile handset using Bluetooth
3.	Basic Programming using NodeMCU. a. Remote control of Electrical appliances using Mobile handset and Wi-Fi b. Local Web server using NodeMCU and displaying Sensor values.
4.	Design and Development of Weather Monitoring System.
5.	Design and Development of Air Pollution identification System.
6.	Design and Development of Automatic Irrigation system.
7.	Design and Development of Theft Identification alert system.
8.	Design and Development of health abnormality alert system.
	Total Hours **30**

Text Books:	
1.	Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob, Henry Jerome, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things", Pearson Education, 2017.
2.	ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2015, ISBN: 978-81-7371-954-7.
3.	Mark Torvalds, "Arduino Programming: Step-by-step guide to mastering arduino hardware and software", 2nd Edition, 2018.
Reference Books:	
1.	Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, 2017.
2.	Srinivasa K. G, Siddesh G. M., Hanumantha Raju R., "Internet of Things", Cengage Learning India Pvt. Ltd., 1st Edition, 2018.
3.	Dr. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", 2nd Edition, McGraw-Hill Education, 2016.
4.	Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, "Internet of Things", Wiley Publication, 2nd Edition, 2020.
Web References:	
1.	https://github.com/connectIOT/iottoolkit
2.	https://www.arduino.cc/
3.	http://www.buyya.com/papers/IoT-Book2016-C1.pdf
4.	https://www.ptc.com/en/technologies/iiot
5.	http://wwwusers.di.uniroma1.it/~spenza/files/labIoT2015/Lab-IoT-1.pdf
Online Resources:	
1.	https://nptel.ac.in/courses/106/105/106105166/
2.	https://www.coursera.org/learn/iot
3.	http://www.iotlab.eu/
4.	http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/
5.	https://www.edx.org/course/introduction-to-the-internet-of-things-iot

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy

Summative assessment based on Continuous and End Semester Examination

Revised	Continuous Assessment	End Semester

Bloom's Level	Theory			Practical	Examination (Theory) [40 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	Rubric based CIA [30 Marks]	
Remember	40	20	30	30	30
Understand	40	30	30	20	30
Apply	20	50	40	30	40
Analyse	-	-	-	20	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C603.1	1	1	2		1	2	1			1		1	3	3	1
C603.2	3	3	3	3	3	1	2			1		2	3	3	3
C603.3	1	2	1	1	2		1		1		1	2	1	1	
C603.4	1	2	3	3	2	2	2			1		1	2	3	2
C603.5	3	3	3	3	3		2		2	1		2	2	3	2
C603.6	3	3	3	3	3		1		2	1		1	2	3	2

20AD604	NLP LABORATORY	0/0/3/1.5

Nature of Course	L (Programming)
Pre-requisite	Data Mining

Course Objectives:

1	To implement the word analysis and generation models.
2	To demonstrate model with N-Grams technique.
3	To apply hidden markov model and analyze the result.
4	To create a real time application model with the help of fundamentals.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C604.1	Understand the implementation of basic concepts.	[U]
C604.2	Learn the techniques apply by N-Grams.	[U]
C604.3	Demonstrate various POS tagging techniques.	[AP]
C604.4	Explain process of phrase extraction.	[U]
C604.5	Build a chunker used for real time application.	[C]
C604.6	Compare and contrast the use of different statistical approaches for different types of NLP applications.	[AP]

Course Contents:

1. Implementation of Word Analysis.
2. Creation of Word Generation.
3. Select a word root and fill the add-delete table using morphology.
4. Implementation of N-Grams.
5. Implementation of N-Grams Smoothing.
6. Calculate emission and transition matrix using Hidden Markov Model.
7. Find POS tags of words in a sentence using Viterbi decoding.
8. Study the context and size of the training corpus in learning Parts of Speech.
9. Implement chunking with regular expression.
10. Implement BERT for text classification.

Total Hours:	**45**

Text Books:

1	Daniel Jurafsky and James H Martin, “Speech and Language Processing”, 2e, Pearson Education, 2019.
2	Dwight Gunning, S. G., “Natural Language Processing Fundamentals: Build Intelligent Applications that Can Interpret the Human Language to Deliver Impactful Results”, Packt publishing, 2019.
3	

Reference Books:

1	James Allen, “Natural language Understanding”, 2e, Pearson Education, 2020.
2	Bharati A, Sangal R, Chaitanya V. (2000), Natural language processing: a Paninian perspective, PHI.
3	Siddiqui T, Tiwary U. S, “Natural language processing and Information retrieval”, OUP, 2018.

Web References:

1	https://www.coursera.org/specializations/natural-language-processing
2	https://www.simplilearn.com/natural-language-processing-training-course

Online Resources:

1	https://nlp-iiith.vlabs.ac.in/exp/word-analysis/objective.html

Assessment Methods & Levels (based on Blooms’Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment (60)	End Semester Examination (40)
Remember	20	20
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	20	20
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C604.1		1	1	1	2								3	2	3
C604.2		1	1	1	2								3	2	3
C604.3	1	3	3	3	2								3	3	3
C604.4	1	3	3	3	3								3	3	3
C604.5		2	2	2	2								3	3	3
C604.6	1	3	3	3	3				1		1	2	3	3	3

20AD701	DATA ANALYTICS	3/0/0/3

Nature of Course	F (Theory Programming)

Course Objectives:

1	Understand the Big Data Platform and its Use cases
2	Learn to build and maintain reliable, scalable, distributed systems with Apache Hadoop
3	Provide an overview of Apache Hadoop
4	To able to apply Hadoop ecosystem components
5	Develop big data solution using Hive.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C701.1	Understand Big Data and its analytics in the real world.	[U]
C701.2	Recognize the analytics tool.	[U]
C701.3	Analyze the Big Data framework like Hadoop to efficiently store and process Big Data to generate analytics.	[A]
C701.4	Design of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm.	[AP]
C701.5	Implement Big Data Activities using Hive ,Hiveql and Hbase.	[AP]

Course Contents:

INTRODUCTION TO BIG DATA

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Four Vs, Drivers for Big data, Big data analytics, Big data applications-Classification of Analytics - Top Analytics Tools.

HADOOP AND MAP REDUCE PROGRAMMING MODEL

Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop - Hadoop Architecture, Hadoop Storage: HDFS Understanding inputs and outputs of MapReduce - MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression.

HIVE AND HIVEQL, HBASE

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting and Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

Total Hours:	**45**

Text Books:

1	Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publications, First Edition, 2015.
2	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007. 2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O"reilly Media, 2011.

Reference Books:

1	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)
2	Tom White, “Hadoop The Definitive Guide”, O’Reilly Publications, Fourth Edition, 2015.

Web References:

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/learn/google-data-analytics-capstone

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C701.1,C701.2	Understand	Quiz	5
C701.3	Analyze	Assignment	5
C701.4,C701.5	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C701.1	3	3	3	2	3	2						2	2	2	2
C701.2	3	3	3	2	3	2						2	2	2	2
C701.3	3	3	3	3	3	2						2	2	2	2
C701.4	3	3	3	2	3	2						2	2	3	3
C701.5	3	3	3	3	3	3						3	3	2	2

20AD702	DEEP LEARNING AND ITS APPLICATIONS	3/0/0/3

Nature of Course	D (Theory Application)
Pre requisites	Artificial Intelligence

Course Objectives:

1	To understand the basics of deep neural networks.
2	To understand CNN of architectures of deep neural networks.
3	To understand the concepts of Artificial Neural Networks.
4	To learn the basics of Data science in Deep learning.
5	To learn about applications of deep learning in AI and Data Science.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C702.1	Explain the basics in deep neural networks.	[U]
C702.2	Apply Convolution Neural Network for image processing.	[AP]
C702.3	Deployment of applications Artificial Intelligence using deep learning.	[A]
C702.4	Apply deep learning algorithms for data science.	[U]
C702.5	Apply deep learning algorithms for variety applications.	[AP]

Course Contents:

MODULE I CONVOLUTIONAL NEURAL NETWORKS **15 Hours**

Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling - Convolution Variants: Strided - Tiled - Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions -- Loss Functions - Regularization - Optimizers - Gradient Computation.

MODULE II DEEP LEARNING ALGORITHMS FOR AI **15 Hours**

Artificial Neural Networks – Linear Associative Networks – Perceptrons -The Backpropagation Algorithm - Hopfield Nets - Boltzmann Machines - Deep RBMs - Variational Autoencoders – Deep Backprop Networks- Autoencoders, LSTM.

MODULE III APPLICATIONS OF DEEP LEARNING **15 Hours**

Detection in chest X-ray images -object detection and classification -RGB and depth image fusion - NLP tasks - dimensionality estimation - time series forecasting -building electric power grid for controllable energy resources - guiding charities in maximizing donations and robotic control in industrial environments. **Case Study:** Sentiment Analysis.

Total Hours:	**45**

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning", MIT Press, 2016.
2	Stone, James. (2019), “Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning”, Sebtel Press, United States, 2019.
3	Vance, William, “Data Science: A Comprehensive Beginners Guide to Learn the Realms of Data Science”, (Hardcover - 2020), Joining the dots tv Limited.

Reference Books:

1	Wani, M.A., Raj, B., Luo, F., Dou, D. (Eds.), “Deep Learning Applications”, Volume 3, Springer Publications 2022.
2	Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook", Springer International Punlishing, 2018.

Web References:

1	https://www.oracle.com/artificial-intelligence/machine-learning/what-is-deep-learning/

Online Resources:

1	https://in.mathworks.com/discovery/deep-learning.html

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C9702.1, C702.3	Analyze	Quiz	5
C702.2, C702.4	Apply	Assignment	10
C702.5	Apply	Demonstration	5

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C702.1	3	3	3	3	3	2			2	2		2	3	2	2
C702.2	3	3	3	3	3	2	2		2	2		2	3	2	2
C702.3	3	3	3	3	2	2	2		2	2		2	3	2	2
C702.4	3	3	3	3	3	2	2		2	2		2	3	3	3
C702.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

20AD703	DATA ANALYTICS LABORATORY	0/0/3/1.5

Nature of Course	J (Problem analytical)
Prerequisites	Data Mining

Course Objectives:

1	To Understand the various hadoop operating modes.
2	To explore file management tasks in Hadoop.
3	To implement Map Reduce programs for processing big data.
4	To solve Big Data problems using pig,hbase,hive commands.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C703.1	Understand the hadoop installation steps.	[U]
C703.2	Demonstrate the knowledge of big data analytics and implement different file management task in Hadoop.	[AP]
C703.3	Understand Map Reduce Paradigm and develop data applications using variety of systems.	[U]
C703.4	Analyze and perform different operations on data using Pig Latin scripts.	[A]
C703.5	Illustrate and apply different operations on relations and databases using Hive.	[AP]

Course Contents:

1. Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, fully distributed.
2. Implement the following file management tasks in Hadoop: Adding files and directories, retrieving files, Deleting files.
3. To study HDFS basic shell commands.
4. Run a basic word count Map Reduce program to understand Map Reduce Paradigm.
5. Write a Map Reduce program that mines weather data
6. Implement matrix multiplication with Hadoop Map Reduce
7. Installation of Pig and Run the Pig Latin Scripts to find Word Count
8. Implement the Pig Latin Scripts to find a max temp for each and every year
9. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
10. Create a table, update, read and delete data using HBase Commands.

Total Hours:	**45**

Text Books:

1	Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publications, First Edition,2015
2	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007. 2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O‟reilly Media, 2011

Reference Books:

1	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)
2	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)

Web References:

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

Assessment Methods & Levels (based on Blooms’Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment (60)	End Semester Examination (40)
Remember	20	20
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	20	20
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C703.1	3	3	1	1	2								3	2	3
C703.2	2	2	1	1	2								3	2	3
C703.3	3	2	3	3	2								3	3	3
C703.4	2	3	3	3	3								3	3	3
C703.5	1	2	3	2	1								3	3	3

20AD704	DEEP LEARNING LABORATORY	0/0/3/1.5

Nature of Course	L (Programming)
Pre requisites	Artificial Intelligence

Course Objectives:

1	To learn deep neural networks and apply for simple problems.
2	To Learn and apply Convolution Neural Network for image processing.
3	To Learn and apply Recurrent Neural Network and its variants for textAnalysis.
4	To explore real world applications with deep neural networks.
5	To learn about applications of deep learning in AI and Data Science.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C704.1	Apply deep neural network for simple problems.	[AP]
C704.2	Apply Convolution Neural Network for image processing.	[AP]
C704.3	Apply Recurrent Neural Network and its variants for text analysis.	[AP]
C704.4	Develop a real-world application using suitable deep neural networks.	[AP]
C704.5	Apply deep learning algorithms for variety applications.	[AP]

Course Contents:

1. Solving XOR problem using Multilayer perceptron.
2. Implement character and Digit Recognition using ANN.
3. Implement the analysis of X-ray image using autoencoders.
4. Implement Speech Recognition using NLP.
5. Develop a code to design object detection and classification for traffic analysis using CNN.
6. Implement online fraud detection of share market data using any one of the data analytics tools.
7. Implement image augmentation using deep RBM.
8. Implement Sentiment Analysis using LSTM.
9. Mini Project: Any application using video analysis.

Total Hours:	**30**

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning", MIT Press, 2016.
2	Stone, James. (2019), “Artificial Intelligence Engines: A Tutorial Introduction to theMathematics of Deep Learning”, Sebtel Press, United States, 2019.
3	Vance, William, “Data Science: A Comprehensive Beginners Guide to Learn the Realms ofData Science”, (Hardcover - 2020), Joiningthedotstv Limited.

Reference Books:

1	Wani, M.A., Raj, B., Luo, F., Dou, D. (Eds.), “Deep Learning Applications”, Volume 3,Springer Publications 2022.
2	Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook", SpringerInternational Punlishing, 2018.

Web References:

1	https://www.oracle.com/artificial-intelligence/machine-learning/what-is-deep-learning/

Online Resources:

1	https://in.mathworks.com/discovery/deep-learning.html

Assessment Methods & Levels (based on Blooms’Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom’s Level	**Rubric based Continuous Assessment (60)**	**End Semester Examination (40)**

Remember	10	10
Understand	20	20
Apply	50	50
Analyse	20	20
Evaluate	-	-
Create	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C704.1	3	3	3	3	3	2			2	2		2	3	2	2
C704.2	3	3	3	3	3	2	2		2	2		2	3	2	2
C704.3	3	3	3	3	2	2	2		2	2		2	3	2	2
C704.4	3	3	3	3	3	2	2		2	2		2	3	3	3
C704.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

20AD901	ARTIFICIAL NEURAL NETWORKS	3/0/0/3
Nature of Course	D (Theory Application)	
Prerequisites	Artificial Intelligence Principles and Techniques	

Course Objectives:

1.	To understand the fundamentals and applications of artificial neural networks.
2.	To familiarize with the different learning models.
3.	To evaluate model performance and interpret results.
4.	To apply Artificial Neural Network Learning techniques to practical problems.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C901.1	Understand the mathematical foundations of neural network models.	[U]
C901.2	Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.	[U]
C901.3	Analyze the concepts and techniques of neural networks through the study of the most important neural network models to apply for suitable applications.	[A]
C901.4	Evaluate whether neural networks are appropriate to a particular application.	[E]
C901.5	Apply neural networks to particular applications and to know what steps to take to improve performance.	[AP]
C901.6	Design and implement neural network systems to solve real world problems.	[AP]

Course Contents:

INTRODUCTION TO ANN **15 Hours**

Overview of Computational Intelligence and Artificial Evolution - Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks. Learning: Learning Algorithms, Error correction and Gradient Descent Rules, Hebbian Learning, Perceptron Learning Algorithm, Perceptron Convergence Theorem - Data Normalization.

SUPERVISED AND UNSUPERVISED TRAINING METHODS **15 Hours**

Single layer perceptron, Multilayer Perceptron, Back Propagation Networks, Radial Basis Function Networks, Convolutional Neural Networks, Recurrent Networks - Hopfield Network - Self Organization Maps - Boltzmann machines – Auto Encoders - Brain-State-in- a Box Network - Associate Memory Network - Associative memory models.

APPLICATIONS OF ANN	**15 Hours**
Function Approximation - Cardiopulmonary Modeling, Pattern Recognition - Tree Classifier Example - Handwritten Pattern Recognition - Self Organization - Serial Killer Data Mining Example, Pulse coupled Neural Networks - Image Segmentation Example. **Case study:** ANN in Retail.	
Total Hours:	**45**

Text Books:	
1.	Kevin L. Priddy and Paul E.Keller, “Artificial Neural Networks: An Introduction”,SPIE Press, 2005.
2.	Simon S Haykin, “Neural Networks a Comprehensive Foundations”, PHI Education, 2010.
3.	Satish Kumar, “Neural Networks A Classroom Approach”, McGraw Hill Education (India) Pvt. Ltd, Second Edition, 2017.

Reference Books:	
1.	B. Yegnanarayana, “Artificial Neural Networks”, PHI Learning Pvt. Ltd, 2010.
2.	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning series), Blayke’s Books, 2017.

Web References:	
1.	https://www.educba.com/types-of-neural-networks/
2.	https://drive.google.com/file/d/0B2iRDvP8jUuAUnpfaDBnQTBWLUU/edit?resourcekey=0-bq1kH6l5hurYT7TtvylSCQ

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C901.1, C901.2, C901.4	Apply	Quiz	5
C901.3, C901.5	Evaluate	Assignment	5
C901.6	Apply	Application Module Development	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	40	40	20	40
Analyse	20	20	20	20
Evaluate	-	-	20	-

Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	3	3	3	2	3	1	1	1	1		1	2	2	2	2
C901.2	3	3	3	2	3	1	1	1	1		1	2	2	2	2
C901.3	3	3	3	3	3	1	1	1	1		1	2	2	2	2
C901.4	3	3	3	2	3	1	1	1	1		1	2	2	3	3
C901.5	3	3	3	3	3	1	1	1	1		1	3	3	2	2
C901.6	3	3	3	3	3	1	1	1	1		1	2	3	3	3

20AD902	SEMANTIC WEB	3/0/0/3

Nature of Course	D (Theory Application)
Prerequisites	Nil

Course Objectives:

1	To learn the fundamentals of semantic web and to conceptualize and depict ontology for semantic web.
2	To make a study of languages for semantic web.
3	To learn about the ontology learning algorithms and to utilize them in the development of an application.
4	To explore appropriate semantic web services and tools for semantic description based on chosen problem domain.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C902.1	Explain how the semantic web technology concept has revolutionized the World Wide Web.	[U]
C902.2	Describe the fundamental concepts in Semantic Web as well as analyze the Classification of Ontologies.	[U]
C902.3	Comprehend technologies including XML and OML	[U]
C902.4	Design semantic web meta data and RDF schema	[AP]
C902.5	Interpret Web service security standards and service models in semantic web services to implement writing rules.	[AP]
C902.6	Develop an application using ontology languages and tools.	[AP]

Course Contents:

MODULE I: SEMANTIC WEB AND ONTOLOGY ENGINEERING 15 Hours

Introduction to the Syntactic web and Semantic web – Evolution of the Web, The Visual and Syntactic Web, Levels of Semantics – Components of Semantic Web – Metadata for web information – Semantic Web Architecture and Technologies: Contrasting Semantic with Conventional Technologies, Semantic Modeling – Ontological Engineering: Ontologies – Classifying Ontologies – Terminological aspects: Concepts, terms, Complex Objects, Subclasses, Upper Ontologies – Ontology Development process and Life Cycle – Methods for Ontology Learning.

MODULE II: LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES 15 Hours

Web Documents in XML – RDF – Schema – Web Resource Description using RDF – RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics Pragmatics – Traditional Ontology Languages: Ontolingua and KIF – LOOM – OKBC – OCML – FLogic – Ontology Markup Languages: SHOE – XOL – RDF – OIL – DAML + OIL – OWL.

MODULE III: SEMANTIC WEB SERVICES AND TOOLS 15 Hours

Introduction – Web Service Essentials: Components of a Web Service – Web Service Security standards – Web Service standardization organizations – OWL-S Service Ontology: Overview – Service Profile – Service Model – Service Grounding – OWL-S Example – Semantic Web Software Tools: Metadata and Ontology Editors – Dublin Core Metadata Editor – OilEd – WebOnto – OntoSaurus – WebODE – OntoEdit – KAON. **Case Study:** Supply chain Management, Healthcare and Lifesciences.

Total Hours: 45

Text Books:

1	Grigoris Antoniou and Frank Van Harmelen, “A Semantic Web Primer”, The MIT Press, Cambridge, Massachusetts London, England, Edition 3,2012.
2	Breitman, Karin, Casanova, Marco Antonio Truszkowski Walt, “Semantic Web: Concepts Technologies and Applications”, Springer Science and Business Media, 2017.

Reference Books:	
1	Pascal Hitzler, Markus Krötzsch and Sebastian Rudolph ,"Foundations of Semantic Web Technologies" Chapman & Hall / CRC, 2009.
2	Jorge Cardoso,"Semantic webservices: Theory, tools and applications", Information science, 2007.
3	Asuncion Gomez-Perez, Oscar Corcha, Mariano Fernandez-Lopez, "Ontological Engineering: with examples from the areas of Knowledge Management, e-Commerce and the Semantic Web", Springer, 2004.
Web References:	
1	http://www.cs.jyu.fi/ai/vagan/itks544.html
2	http://videolectures.net/iswc08_hendler_ittsw/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C902.1, C902.2, C902.3	Understand	Quiz	5
C902.4, C902.5	Apply	Assignment	5
C902.6	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C902.1	3	3	3	2	3	2						2	2	2	2
C902.2	3	3	3	2	3	2						2	2	2	2
C902.3	3	3	3	3	3	2						2	2	2	2
C902.4	3	3	3	2	3	2						2	2	3	3
C902.5	3	3	3	3	3	3						3	3	2	2
C902.6	3	3	3	3	3	3						2	3	3	3

20AD903	INTRODUCTION TO DISTRIBUTED SYSTEMS	3/0/0/3

Nature of Course	G (Theory Analytical)
Prerequisites	Operating Systems

Course Objectives:

1	To learn the principles, algorithms and programming models used in distributed systems.
2	To examine state of the art distributed file systems.
3	To explore faults and recovery in distributed systems.
4	To understand the issues involved in the recovery process and resource management.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C903.1	Understand the core concepts of distributed systems.	[U]
C903.2	Design and develop distributed programs using RPC/RMI.	[AP]
C903.3	Analyze time and global state in distributed systems and algorithms.	[A]
C903.4	Analyze the design and functioning of distributed file systems.	[A]
C903.5	Demonstrate concurrency control and transaction in Distributed systems.	[AP]
C903.6	Design process and resource management systems.	[AP]

Module I - InterProcess and Remote Communication **15 Hours**

Distributed Systems – Examples – Design issues and challenges - Trends .**System Model**:– Interprocess Communication- **Network virtualization**: Overlay networks**. Remote Invocation:** Request-reply protocols – Remote procedure call – Remote method invocation. **Case Study**: Java RMI. Group Communication – Publish subscribe systems- Message queues.

Module II Distributed File system and Naming **15 Hours**

Clocks, events and process states –clock synchronization - Logical time and logical clocks. Global state – Cuts –Past and future cones of an event – Snapshots .**Distributed mutual exclusion** : Ricart-Agrawala algorithm – Maekawa's algorithm – Suzuki–Kasami's broadcast algorithm- Leader Elections. **Distributed File System**- Introduction – File service architecture –Network file System- Andrew File system **Case Study**: Hadoop Distributed File System(HDFS),Bigtable / HBase MapReduce, RDD. **Naming:** Identifiers, Addresses, Name Resolution – Name Space Implementation – Name Caches – LDAP.

Module III Coordination and Transactions **15 Hours**

Transactions: Nested transactions- Optimistic concurrency control-Timestamp Ordering-Atomic Commit protocols - Distributed Deadlock –Transaction Recovery **Replication** - Fault tolerant and recovery: fault models - agreement problems and its applications - commit protocols - voting protocols - Checkpointing and recovery. **Case Study:** Apache Spark, Amazon Aurora, BlockChain Systems. **Resource Management:** Introduction- Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach.

Total Hours: 45

Text Books:

1.	George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems Concepts and Design", Fifth Edition, Pearson Education, 2012.
2	Tanenbaum A.S., Van Steen M., "Distributed Systems: Principles and Paradigms", Pearson Education, 2007.

Reference Books:

1	Pradeep K Sinha, "Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007.
2	Liu M.L., "Distributed Computing, Principles and Applications", Pearson Education, 2004.
3	Nancy A Lynch, "Distributed Algorithms", Morgan Kaufman Publishers, USA, 2003.

Web References:

1	https://en.wikipedia.org/wiki/Distributed_computing
2	https://link.springer.com/article/Distributed systems
3	https://www.coursera.org/courses/distributed systems
4	https://www.javatpoint.com/distributed-operating-system
Online Resources:	
1	https://www.udemy.com/topic/distributed-computing
2	https://nptel.ac.in/courses/106/106/106106168/
3	Resource Management, Springer

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C903.1,C903.2	Apply	Online Quiz	5
C903.3,C903.4	Analyze	Case Study	5
C903.5,C903.6	Apply	Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 Marks]
	Theory			
	CIA1 (10 Marks)	CIA2 (10 Marks)	CIA3 (10 Marks)	
Remember	20	20	20	20
Understand	40	40	20	30
Apply	40	-	30	20
Analyse	-	40	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C903.1	3	3	2	2								2	3		
C903.2	3	3	3	2								2	3		
C903.3	3	3	2	2								2	3		
C903.4	3	3	2	2								2	3		
C903.5	3	3	3	2								2	3		3
C903.6	3	3	3	2								2	3		3

20AD904	VIRTUAL REALITY AND AUGMENTED REALITY	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	Nil

Course Objectives:

1	To understand the basic concepts of Virtual Reality.
2	To know input and output devices of virtual Reality.
3	To understand the interaction techniques of VR.
4	To outline the design and evaluation methods in VR.
5	To discuss applications of VR in various industries.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C904.1	Understand the requirements of virtual and augmented reality.	[U]
C904.2	Know the usage of hardware and software in VR.	[R]
C904.3	Discover the various manipulation and interactive techniques.	[AP]
C904.4	Compare the difference between augmented and virtual reality.	[AP]
C904.5	Examine the design and evaluation methods.	[A]
C904.6	Implement Virtual/Augmented Reality Applications.	[A]

Course Contents:

MODULE I Introduction to Virtual Reality **15 Hours**

History of VR – Key Elements of VR - VR Paradigms - Input: User Monitoring – World Monitoring - Output devices: Visual Displays – Visual Representation in VR(Aural and Haptic) – Navigation. .

MODULE II Visual Rendering , Perception and Interactive Technique **15 Hours**

Visual Rendering - Depth perception - Motion perception - Stroboscopic Apparent Motion - Color perception – 3D Manipulation task and technique - Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp - Features of augmented reality, Difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, Visualization techniques for augmented reality.

MODULE III – Design and 3D interfaces **15 Hours**

Experience Designs – The Process for Designing User Experience for Virtual Reality - Three I's of VR - Immersion, Interaction, Imagination - Emotional Experience – Social Experience - Evaluation of VR – 3D Unity Architecture – Graphics – VR interfaces and ARKit support – Application of AR and VR - **Case study:** AR and VR in Industry.

Total Hours: 45

Text Books:

1	Alan B Craig, William R Sherman, Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann Publishers, 2009.
2	Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494.
3	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
4	Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.

Reference Books:

1	Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Inter science, India, 2003.
2	William R Sherman and Alan B Craig, "Understanding Virtual Reality, Interface, Application and Design",(The Morgan Kaufmann Series in Computer Graphics)", Morgan Kaufmann Publishers, San Francisco, CA, 2002

3	Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Merging Real and Virtual Worlds”, 2005.
Web References:	
1	http://lavalle.pl/vr/book.html
2	https://www.coursera.org/learn/introduction-virtual-reality
3	https://uxplanet.org/designing-user-experience-for-virtual-reality-vr-applications-fc8e4faadd96
4	https://virsabi.com/virtual-reality-experience-design/

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C904.1,C904.2	Apply	Quiz	5
C904.3,4,5	Apply	Assignment	5
C904.6	Analyze	Case Study	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C904.1	2	1	3		3								3	3	3
C904.2	3	3	2	3	2								3	2	3
C904.3	3	3	2										3		3
C904.4	2	1	2										2		2
C904.5	2	2	2										2		2
C904.6	2	1	2	3				1	1	1	1	1	3	3	3

20AD905	BIO INFORMATICS	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	Data Warehousing and Mining

Course Objectives:

1	To identify the need and role of bioinformatics technologies and apply this to the solution of biological problems.
2	To discover biological data, interpret and apply data warehousing and data mining in bioinformatics.
3	To examine appropriate models, data visualization techniques and model biological information.
4	To apply genome annotation, gene prediction, phylogenetic analysis and microarray analysis technologies.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C905.1	Interpret the need and role of bioinformatics data and technologies.	[U]
C905.2	Develop an understanding of bioinformatics data and systems by articulating the data warehousing and data mining technologies.	[U]
C905.3	Determine the models for biological data analysis and visualize the bioinformatics data.	[AP]
C905.4	Apply pattern matching techniques to bioinformatics data like protein data and genomic data.	[AP]
C905.5	Illustrate the use of technologies for genome annotation, gene prediction and phylogenetic analysis.	[AP]
C905.6	Apply micro array technology for genomic expression study and analysis.	[AP]

Course Contents:

MODULE I Bioinformatics data and technologies **15 Hours**

Need for Bioinformatics technologies – Overview of Bioinformatics technologies - Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics – Biological Data Integration System. Data warehousing and Data mining in Bioinformatics - Bioinformatics data – Data warehousing architecture – Data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics.

MODULE II Modeling, Pattern Matching And Visualization **15 Hours**

Hidden markov modeling for biological data analysis – Sequence identification – Sequence classification – Multiple alignment generation – Comparative modeling – Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks - Molecular modeling – Computer programs for molecular modeling - Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization – Fractal analysis – DNA walk models - Game representation of Biological sequences – DNA, Protein, Amino acid sequences.

MODULE III Applications **15 Hours**

Genome Annotation and Gene Prediction; ORF finding- Genome analysis; Phylogenetic Analysis: Comparative genomics, orthologs, paralogs. Microarray Analysis. Microarray technology for genome expression study, image analysis for data extraction, preprocessing, segmentation, gridding, spot extraction, normalization, filtering, cluster analysis, gene network analysis, Compared Evaluation of Scientific Data Management Systems, Cost Matrix, Evaluation model - Benchmark – Tradeoffs. **Case study:** Genome Analysis of SARS-CoV-2, BLAST, Bioinformatics Databases.

Total Hours: 45

Text Books:

1	Yi-Ping Phoebe Chen, “BioInformatics Technologies”, Springer Berlin Heidelberg, 2014.
2	Arthur K. Lesk, “Introduction to Bioinformatics”, Oxford University Press, 2019.
3	Bryan Bergeron,”Bio Informatics Computing”, Second Edition, Pearson Education, 2003.

Reference Books:	
1	Pierre Baldi and Soren Brunak, “Bioinformatics, The Machine Learning Approach”, MIT Press, 2001.
2	Zoe Lacroix and Terence Critchlow, “BioInformatics, Managing Scientific data”, Elsevier, 2003.
3	Stanley I. Letovsky ,”Bioinformatics: Databases and Systems”, Springer; 2006.
4	D.E. Krane and M.L. Raymer, “Fundamental concepts of bioinformatics”, Pearson Education, 2006.
Web Resources:	
1	https://onlinecourses.nptel.ac.in/noc21_bt06/preview
3	https://www.coursera.org/learn/bioinformatics
Online References:	
1	http://bioinfo.mbb.yale.edu/mbb452a/intro/
3	https://serc.carleton.edu/exploring_genomics/chamaecrista/bioinformatics_.html

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C905.1, C905.2,	Understand	Quiz	5
C905.3, C928.4,	Apply	Group Assignment	10
C905.5. C905.6	Apply	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C905.1	3	3	3	2	3							2	3	3	3
C905.2	3	3	3	2	3							2	3	3	2
C905.3	3	3	3	3	3							2	3	3	2
C905.4	3	3	3	2	3							2	3	3	3
C905.5	3	3	3	3	3							3	2	2	2
C905.6	3	3	3	3	3							2	2	2	2

20AD906	ETHICS IN DATA SCIENCE	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	Data Science

Course Objectives:

1	To understand the need of ethics in data science.
2	To know about privacy and their risk.
3	To be familiar with choice of attributes.
4	Interpret and apply a professional code of ethics relevant to the data science profession.
5	To identify ethics in real time with the help of case studies.

Course Outcomes:

Upon completion of the course, students shall have ability to

C906.1	Identify and analyze the ethical needs in data science.	[U]
C906.2	Articulate the privacy degree and risk.	[U]
C906.3	Apply ethical frameworks to help them analyze ethical challenges.	[AP]
C906.4	Analyze the errors in processing the data and design.	[A]
C906.5	Develop the data based on guiding principles.	[AP]
C906.6	Examine ethics in various real time examples.	[A]

Course Contents:

MODULE I Introduction to Ethics and Data Privacy **15 Hours**

Ethics – Data Science needs ethics – Five C's - Informed Consent – Limitations in informed Consent - Privacy – History of Privacy – Degree of Privacy – Modern Privacy risk - Policy guidelines.

MODULE II Significance of Ethics **15 Hours**

Algorithmic Bias –Policy Guidelines - Ethical Rules- Ethical Frameworks - Ethical Challenges – Best Practices for practitioners and users - Data Validity – Choice of attribute and measure – Errors in Data Processing – Errors in Model Design.

MODULE III Building Ethics **15 Hours**

Code of Ethics – Wrap up – Ethics and security training – Developing guiding principles – Building ethics into data driven culture – Regulation – **Case studies:** Algorithm Fairness, Social Credit Scores, Target Ads.

Total Hours: 45

Text Books:

1	Mike Loukides, Hilary Mason, Dj Patil, "Ethics in Data Science", O'Reilly Media, Inc, 2018.
2	Bill Franks, "97 Things About Ethics Everyone in Data Science Should Know", O'Reilly Media, Inc, August 2020.

Reference Books:

1	Shannon Vallor, William J. Rewak, S.J., "An Introduction to Data Ethics", Santa Clara University, 2018.
2	John D. Kelleher, Brendan Tierney, "Data Science", MIT Press, 2018.

Web References:

1	https://www.coursera.org/learn/data-science-ethics
2	https://ethics.fast.ai/syllabus/#lesson-1-disinformation

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C906.1,C906.2	Understand	Quiz	5
C906.3,C906.5	Apply	Assignment	5

C906.4	Analyze	Case Study	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	40	40	40	40
Analyze	20	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C906.1	1	3			2		2	3					3	2	
C906.2	3	2					2	3			2		3		
C906.3	3		3		2		2	3						3	
C906.4		2			2		2	3					3	3	
C906.5		2					2	3			3		2	2	3
C906.6		2			2		2	3			2	2			

20AD907	SENTIMENT ANALYSIS	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Data Mining

Course Objectives:

1	To recognize the basic concepts of sentiment analysis.
2	To apply the ideas of sentiment composition and entity extraction.
3	To examine the intention mining operations and spam detection techniques.
4	To realize the Model-Based Behavioral Analysis.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C907.1	Distinguish the concepts of sentiment analysis.	[U]
C907.2	Discover the sentiment analysis as Mini NLP.	[U]
C907.3	Identify the appropriate sentiment composition and entity extraction .	[A]
C907.4	Analyze the performance of sentiment word sense disambiguation.	[A]
C907.5	Illustrate Intention Mining and Model-Based Behavioral analysis.	[AP]
C907.6	Apply the concepts of spam detection techniques.	[AP]

Course Contents:

MODULE I Introduction to Sentiment Analysis **15 Hours**

Sentiment Analysis Task - Different Types of Opinions - Sentiment Classification- Sentiment Rating Prediction - Emotion Classification - Sentence Subjectivity - Subjectivity Classification- Sentiment Analysis as Mini NLP.

MODULE II Sentiment Composition and Entity Extraction **15 Hours**

Sentiment Composition Rules - Senses of Sentiment Words - Expressions - Negation and Sentiment - Modality and Sentiment - Sentiment Words in Non-opinion Contexts - Word Sense Disambiguation - Frequency-Based Aspect Extraction - Exploiting Syntactic Relations - Mapping Implicit Aspects- Exploiting Topic Models - Entity Extraction and Resolution.

MODULE III Mining Intentions and Spam Detection **15 Hours**

Problem of Intention Mining - Intention Classification - Fine-Grained Mining of Intentions - Harmful Fake Reviews - Types of Spammers and Spamming - Types of Data, Features, and Detection - Automated Discovery of Abnormal Patterns - Model Based Behavioral Analysis - Group Spam Detection - **Case Study** : Identifying Reviewers with Multiple User Ids.

Total Hours: 45

Text Books:

1	Locke, K, “Sentiment Analysis: Mining Opinions, Sentiments and Emotions”, Cambridge University Press, 2nd Edition, 2020.
2	Erik Cambria, Sivaji Bandyopadhyay, Dipankar Das, Antonio Feraco, “A Practical Guide to Sentiment Analysis”, Springer International Publishing, 2018.

Reference Books:

1	Basant Agarwal and Namita Mitta, “Prominent Feature Extraction for Sentiment Analysis”, Basant Agarwal and Namita Mittal, Springer International Publishing, 2015.
2	Bo Pang and Lillian Lee, “Opinion Mining and Sentiment Analysis”, Now Publisher Inc, 2008.
3	Amir Hussain, Erik Cambria, and Soujanya Poria, “Multimodal Sentiment Analysis”, Springer International Publishing, 2018.

Web References:

1	https://monkeylearn.com/sentiment-analysis/
2	https://towardsdatascience.com/sentiment-analysis-concept-analysis-and-applications-6c94d6f58c17
3	https://www.lexalytics.com/technology/sentiment-analysis

Online Resources:

1	https://www.coursera.org/projects/scikit-learn-logistic-regression-sentiment-analysis
2	https://www.udemy.com/topic/sentiment-analysis/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C907.1, C907.2	Understand	Quiz	5
C907.3,C907.4	Analyze	Assignment	5
C907.5, C907.6	Apply	Presentation	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C907.1	3	3	3	3	2	2		2		3		2	2	2	2
C907.2	3	3	3	3	2	2		2		3		2	2	2	2
C907.3	3	3	3	3	3	3		3		3		2	2	2	2
C907.4	3	3	3	3	2	2		3		3		2	2	3	3
C907.5	3	3	3	3	3	3		3		3		3	3	2	2

20AD908	INFORMATION EXTRACTION AND RETRIEVAL	3/0/0/3

Nature of Course	G (Theory Analytical)
Prerequisites	Data mining

Course Objectives:

1	To outline basic terminology and components in information retrieval.
2	To understand the concepts of IR models.
3	To explore information extraction and integration.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C908.1	Understand the basic concepts in Information Retrieval.	[U]
C908.2	Analyze the searching and indexing techniques.	[A]
C908.3	Understand the link analysis for ranking.	[U]
C908.4	Apply classification and clustering techniques on text documents.	[AP]
C908.5	Evaluate the effectiveness of information retrieval methods.	[E]
C908.6	Able to understand extraction of information and integration.	[U]

Course Contents:

Module I - Introduction **15 Hours**

History, Components of IR – Open source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search - Characterizing the web. **Querying:** Preprocessing - wildcard queries, Phrase Queries - Relevance Feedback - Query expansion. **Models:** Boolean and vector-space retrieval models - Term weighting - TF - IDF weighting - cosine similarity –- efficient processing with sparse vectors – Language Model based IR - Probabilistic IR –Latent Semantic Indexing. **Searching and Indexing:** Web Search Architectures - crawling - meta crawlers - Focused Crawling - Inverted indices - web indexes – Near-duplicate detection - Index Compression – XML retrieval

Module II - Link Analysis , Classification and Clustering **15 Hours**

Link Analysis: Hubs and Authorities – Page Rank and HITS algorithms- Evaluation- metrics Recall, Precision and F measure – Evaluations on Benchmark Text Collections – Text Representation – Word Statistics – Morphology – Index Term Selection using Thesauri –Metadata and Markup Languages . **Classification-** Text classification and clustering - Categorization algorithms: Naive Bayes; decision trees; and nearest neighbour, Support Vector Machine – **Clustering algorithms:** Flat clustering, Hierarchical Clustering, Agglomerative clustering, K-means, Expectation Maximization (EM) - Semantic Matching using Neural Networks. Recommendation System.

Module III: Information Extraction **15 Hours**

Integration of Information extraction- Entity Extraction-Rule based methods and Statistical methods- Extracting Data from Text – XML – Ontologies, thesauri, semantic web – Collecting and Integrating Specialized Information on the Web - Evaluation of Information extraction Technologies **Case Study:** Organizations and Information systems data in Traditional file Environment, Biomedical Texts and Business Texts.

Total Hours:	**45**

Text Books:

1.	Christopher D.Manning, Prabhakar Raghavan,Hinrich Schutze, “Introduction to information retrieval”, Cambridge university press, first south asian edition, 2012.
2	Ricardo Baeza-Yates, Berthier Ribeiro-Neto, “Modern information retrieval: The concepts and technology behind search”,ACM press books, second edition, 2011.
3.	Marie Francine Moens, “Information Extraction: Algorithms and Prospectus in a Retrieval Context”, 2010.

Reference Books:

1	Stephen Buettcher, Charles L.A. Clarke and Gordon V. Carmack, “Information Retrieval: Implementing and Evaluating Search Engines”, MIT Press, 2010

2	Bruce Croft, Donald Metzler and Trevor Strohman, “Search Engines: Information Retrieval in Practice”, 1st Edition Addison Wesley, 2009.
3	Mark Levene, “An Introduction to Search Engines and Web Navigation”, 2nd Edition, Wiley, 2010.
Web References:	
1	Information Retrieval,Wiley
2	https://www.coursera.org/courses/information/retrieval
3	https://www.sciencedirect.com/topics/computer-science/information-retrieval-systems
4	https://en.wikipedia.org/wiki/Information_retrieval
Online Resources:	
1	https://cse.iitkgp.ac.in/~pabitra/course/ir06/ir06.html
2	Information Extraction and Integration, Springer
3	Search engine, Springer

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C908.1,C908.2	Analyze	Online Quiz	5
C908.3,C908.4	Apply	Assignment	10
C9208.5,C908.6	Evaluate	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment – Theory			End Semester Examination [50 Marks]
	CIA1 (10)	CIA2 (10)	CIA3 (10)	
Remember	20	10	10	20
Understand	20	20	20	30
Apply	20	40	30	30
Analyse	40	30	30	10
Evaluate	-	-	10	10
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C908.1	3	3	3	2								3	3	2	
C908.2	3	3	3	2								3	3	3	
C908.3	3	3	3	3	2							3	3	3	
C908.4	3	3	3	2	3							3	3	3	2
C908.5	3	3	3	3	3							3	3	3	2
C908.6	3	3	3	3								3	3	2	3

20AD909	COGNITIVE SYSTEMS	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	Artificial Intelligence

Course Objectives:

1	Understand the basics of cognitive science.
2	Articulate the interdisciplinary nature with artificial intelligence.
3	Identify the research methods in cognitive systems.
4	Familiarize with technical systems capable of independently solving and developing strategies for human tasks.
5	Simulate human thought processes in a computerized model.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C909.1	Identify the relation between language, action and perception in human interaction.	[U]
C909.2	Compare the existing computational resources, approaches, and applications.	[U]
C909.3	Analyze how language, action and perception are modeled in the computational field.	[A]
C909.4	Recognize problems and formulate new questions for the computational modelling.	[U]
C909.5	Interpret the real-world application of cognitive systems.	[AP]
C909.6	Categorize the probabilistic models of cognition.	[A]

Course Contents:

MODULE I PHILOSOPHY, PSYCHOLOGY AND NEUROSCIENCE **15 Hours**

Philosophy: Mental-physical Relation – From Materialism to Mental Science – Detour before the naturalistic turn – The Philosophy of Science – The Mind in Cognitive Science – Logic and the Sciences of the Mind – Psychology: Place of Psychology within Cognitive Science - Science of Information Processing – Neurosciences: Cognitive Neuroscience – Perception - Decision – Learning and Memory – Language Understanding and Processing.

MODULE II PROBABILISTIC MODELS OF COGNITION **15 Hours**

Introduction – Generative Models: Models, simulation and degrees of belief - Building Generative Models - Example: Flipping Coins - Causal Models in Medical Diagnosis – Conditioning - Cognition and Conditioning - Hypothetical Reasoning with Infer - Rejection Sampling - Conditional Distributions - Connection to rejection sampling – Bayes Rule.

MODULE III IMPLEMENTING THE LEARNING MODELS OF COGNITION **15 Hours**

Learning as Conditional Inference: Example: Learning about coins - Independent and Exchangeable Sequences - Subjective Randomness - Learning a Continuous Parameter - Learning with a Language of Thought: Inferring an Arithmetic Function – Hierarchical Models: Abstraction – Occam's Razor: The size principle – Mixture Models: Learning Categories - Learning (Deep) Continuous Functions: Fitting curves with neural nets - A case study in cognitive control of autonomous systems.

Total Hours: 45

Text Books:

1	Robert A. Wilson, Frank C. Keil, "The MIT Encyclopedia of the Cognitive Sciences", The MIT Press, 2001.
2	Noah D. Goodman, Joshua B. Tenenbaum, "Probabilistic Models of Cognition", The ProbMods Contributors, Second Edition, 2016.

Reference Books:

1	Philip J. Smith, Robert R. Hoffman, “Cognitive Systems Engineering: The Future for a Changing World (Expertise: Research and Applications Series)”, October 2017.
2	David Vernon, Artificial Cognitive Systems – A Primer (The MIT Press), January 2015.
3	Richard Morris, Lionel Tarassenko, Michael Kenward, “Cognitive Systems - Information Processing Meets Brain Science Book”, 2006.

Web References:	
1	http://www.nptel.ac.in
3	https://probmods.org/

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C909.1, C909.2, C909.3	Apply	Quiz	5
C909.4, C909.5	Apply	Assignment	5
C909.6	Analyze	Smart Programming Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	40	40	40	40
Analyze	20	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C909.1	3	3	3	2	3							2	2	2	2
C909.2	3	3	3	2	3							2	2	2	2
C909.3	3	3	3	3					3			2	2	2	2
C909.4	3	3	3	2					3			2	2	3	3
C909.5	3	3	3	3					3			3	3	2	2
C909.6	3	3	3	3	3							2	3	3	3

20AD910	INTELLIGENT DATA BASE SYSTEM	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	DBMS

Course Objectives:

1	To analyze learning systems.
2	To study the Database installation and create databases by using SQL.
3	To get exposure to many real-world control problems.
4	To determine which type of intelligent system methodology would be suitable for a given type of application problem.
5	To design and create small real time applications.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C910.1	Understand the basic artificial intelligence techniques.	[U]
C910.2	Understand the concepts of knowledge-based systems and apply them with AI.	[U]
C910.3	Describe the attributes of knowledge-based systems and the situations to which they are well-suited.	[A]
C910.4	Create Rules for Detective Database Systems.	[AP]
C910.5	Apply their knowledge to design solutions to different problems.	[AP]
C910.6	Design and develop an intelligent system for a selected application.	[AP]

Course Contents:

MODULE I SEMANTIC DATA MODELS **15 Hours**

Informal definition of the domain - General characteristics of IDBSs - Data models and the relational data model - A taxonomy of intelligent database systems. Nested and semantic data models – Introduction - The nested relational model - Semantic models - Hyper-semantic data models - Object-oriented approaches to semantic data modeling – Object oriented database systems - Basic concepts of a core object-oriented data model - Comparison with other data models.

MODULE II KNOWLEDGE BASED SYSTEMS - AI CONTEXT **15 Hours**

Characteristics and classification of the knowledge based systems – Introduction - The resolution principle - Inference by inheritance - Deductive database systems - Basic concepts - DATALOG language - Deductive database systems and logic programming systems—differences - Architectural approaches - Research prototypes - Updates in deductive databases - Integration of deductive database and object database technologies - Constraint databases.

MODULE III APPLICATIONS IN IDBS **15 Hours**

Introduction - Temporal databases - Basic concepts - Temporal data models - Temporal query languages – Internet indexing and retrieval - Basic indexing methods - Search engines or meta-searchers - Internet spiders - Data mining - Data mining tasks - Data mining tools - Medical and legal information systems - Medical information systems - Legal information systems. **Case study**: Design and develop a project using a medical information system.

Total Hours: 45

Text Books:

1	Panos Alexopoulos, "Semantic Modeling For Data: Avoiding Pitfalls And Breaking Dilemmas", O'Reilly , 2020.
2	N.P. Padhy,"Artificial Intelligence and Intelligent Systems" Oxford Press, 2015.

Reference Books:

1	Elisa Bertino, Barbara Catania, GianPieroZarri, “Intelligent Database Systems”,Collection ACM Press, 2001.

2	Leondes CT, "Intelligent Knowledge-Based Systems", Kluwer Academic Publishers, 2005.
Web References:	
1	https://www.eyrolles.com/Informatique/Livre/intelligent-database-systems-9780201877366/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C910.1 & C910.2	Understand	Quiz	5
C910.3 & C910.4	Analyze	Assignment	5
C910.5 & C910.6	Apply	Application - Poster Presentation	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	40	20	20	20
Apply	40	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C910.1	1	1	2	3	2							1	2	2	2
C910.2	1	1	3	3	3							2	3	3	3
C910.3	1	1	3	2	3							1	3	3	2
C910.4	2	2	3	3	3							2	2	3	3
C910.5	2	2	3	3	3							2	2	3	3
C910.6	1	2	3	2	3							1	3	3	3

20AD911	IMAGE SIGNAL PROCESSING	3/0/0/3
Nature of Course	G (Theory & Analytical)	
Pre-Requisite	Fundamentals of Signals and Systems	

Course Objectives:

1	To make students understand Discrete Fourier Transform techniques and basic multi-rate signal processing.
2	Understand the fundamentals of digital imaging.
3	To be apply to apply basic image processing techniques like enhancement, segmentation, morphological etc.
4	To learn and apply image compression techniques.

Course Outcomes:
Upon completion of the course, students shall have ability to

C911.1	Understand Discrete Fourier Transform techniques to evaluate	[U]
C911.2	To apply multi-rate signal processing techniques like decimation & interpolation.	[AP]
C911.3	Understand the fundamentals of digital imaging.	[U]
C911.4	To be able to apply image enhancement techniques to images in both spatial & frequency domain.	[AP]
C911.5	Apply segmentation, morphological processing techniques to input images.	[AP]
C911.6	To understand & analyze image compression techniques and models.	[AN]

Course Contents:

Digital Signal Processing: 15 Hours

Computation of DFT, Properties of DFT, Circular convolution, Fast Fourier Transforms (FFT) algorithms – Decimation in Time algorithm, Decimation in Frequency algorithms, DFTs in linear filtering – overlap add & overlap save methods. Multirate DSP – Decimation, Interpolation.

Digital Image Fundamentals & Image Enhancement 15 Hours

Fundamental steps, Components of image processing system, Elements of visual perception, Image sampling & quantization, Basic relationships between pixels, Image Enhancement: Spatial Domain: Basic intensity transformation functions, Histogram processing, Spatial Filtering–Smoothing and Sharpening Spatial Filters, Frequency Domain: Introduction to Fourier Transform, Frequency domain filtering - Smoothing and Sharpening frequency domain filters, Homomorphic filtering.

Digital Image Segmentation, Morphological Processing & Compression: 15 Hours

Image Segmentation - Segmentation concepts, point, line and Edge detection, Thresholding, Region based segmentation. Morphological image processing - Erosion & dilation, Opening & closing, Image Compression models: Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding, JPEG, MPEG standards.

Total Hours:	**45**

Text Books:

1	John G. Proakis& Dimitris G. Manolakis, “Digital Signal Processing”, Pearson, 4th edition, 2019.
2	Rafael C. González ,Richard E Woods, “Digital image processing” Pearson Education,Third Edition, 2014.

Reference Books:

1	W. K. Pratt, “Digital Image Processing”, John Wiley and Sons, Second Edition, 2008.

2	Sanjit K. Mitra, "Digital Signal Processing: A Computer-Based Approach", The McGraw-Hill Education, 4th Edition, 2013.
Web References:	
1	https://www.tutorialspoint.com//digital signal processing/index.htm
2	http://web.stanford.edu/class/ee368/handouts.html
3	http://www.ee.columbia.edu/~sfchang/course/dip/
Online Resources:	
1	nptel.ac.in/downloads/117104020/
2	https://www.edx.org/course/computer-vision-image-analysis-1
3	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C911.1	Remember	Quiz	3
C911.2	Understand	Assignment	3
C911.3	Understand	Quiz	3
C911.4	Understand	Assignment	3
C911.5	Analyse	Quiz	3
C911.6	Apply	Group Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	30	20	20
Understand	20	30	30	40
Apply	20	40	50	20
Analyse	-	-	-	-
Evaluate	40	-	-	20
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C911.1		1	1	1	2								3	2	3
C911.2		1	1	1	2								3	2	3
C911.3	1	3	3	3	2								3	3	3
C911.4	1	3	3	3	3								3	3	3
C911.5		2	2	2	2								3	3	3
C911.6	1	3	3	3	3				1		1	2	3	3	3

20AD912	COMPUTATIONAL STATISTICS FOR DATA SCIENCE	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	Python for Data Science

Course Objectives:

1	To introduce computational statistics concepts.
2	To study the basics of probability and statistical model.
3	To determine which type of sampling distribution would be suitable for a given type of application problem.
4	To design and create small real time applications using statistical model.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C912.1	Understand the basic computational statistics.	[U]
C912.2	Understand the concepts of exploratory data analysis.	[U]
C912.3	Describe the attributes of sampling distributions that can be applied over data.	[A]
C912.4	Create Rules for multi variable distribution.	[AP]
C912.5	Apply knowledge to design solutions to different problems.	[AP]

Course Contents:

MODULE I EXPLORATORY DATA ANALYSIS **15 Hours**

Elements of structured data – Rectangular Data – Estimates of Location – Estimates of variability – Exploring the data distribution – Exploring Binary and Categorical Data – Exploring two or more variables.

MODULE II DATA AND SAMPLING DISTRIBUTIONS **15 Hours**

Random sampling and sample bias – selection bias – sampling distribution of a statistic – The bootstrap – Confidence intervals – Normal distribution – Long tailed distribution – Binomial distribution – Poisson distribution – Graphical Neural Network.

MODULE III BAYESIAN MODELLING AND APPLICATIONS **15 Hours**

Bayesian Statistics – Markov Chain Monte Carlo Methods for Bayesian modeling – PyMC3 for Bayesian Modeling and Inference – Applications of Statistical Models – **Case Study:** Hybrid Feature Vector-Assisted Action Representation for Human Action Recognition Using Support Vector Machines, Use PyMC3 to model the disease dynamics of and infer the parameters of an SIR model of COVID-19 from real-world data.

Total Hours:	**45**

Text Books:

1	Peter C.Bruce and Andrew C.Bruce, “Statistics for Data Scientists”, O’Reilly, 2018.
2	Geof H. Givens and Jennifer A. Hoeting,” Computational Statistics” Second Edition, Wiley Publications, 2018.

Reference Books:

1	Dawn Griffiths, “Head First Statistics: A Brain-Friendly Guide”, O’Reilly, 2018.
2	Christian Heumann, Michel Schomaker, “Introduction to statistics and Data Analysis”, Springer Publishers, 2020.

Web References:

1	https://www.coursera.org/specializations/compstats
2	https://www.stat.colostate.edu/computationalstatistics/
3	https://www.analyticssteps.com/blogs/introduction-graph-neural-network-gnn

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C912.1 & C912.2	Understand	Quiz	5
C912.3 & C912.4	Analyze	Assignment	5
C912.5	Apply	Application - Poster Presentation	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	40	20	20	20
Apply	40	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

COs	POs												PSOs		
C912.1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C912.2	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C912.3	3	3	3	3	2	2	2	3			2	3	3	3	2
C912.4	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C912.5	3	3	3	3	2	2	2	3			2	3	2	2	3
C912.1	3	3	2	2	3	3	3	3			2	2	3	3	3

3	Strongly Agree	2	Moderately Agreed	1	Weekly Agreed

20AD913	BAYESIAN DATA ANALYSIS	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	Nil	

Course Objectives:

1.	To learn basic concepts of Bayesian analysis.
2.	To introduce the Bayesian concepts and methods with emphasis on data analysis.
3.	To assess the outcome of prior distributions as well as posterior means.
4.	To identify the optimal model and to learn how to apply the same in suitable applications.

Course Outcomes

Upon completion of the course, students shall have ability to

C913.1	Understand the basics of probability and relate it to the Bayesian inference.	[U]
C913.2	Apply the inference rules customized for single parameter models.	[AP]
C913.3	Examine the simulation environment for generation of inferences by utilizing various algorithms.	[A]
C913.4	Analyze the inference mechanism for multi-parameter and hierarchical models.	[A]
C913.5	Identify multiple modeling algorithms for predictive analysis and evaluate the outcome metrics	[AP]
C913.6	Apply the inference mechanism effectively in different nonlinear models.	[AP]

Course Contents:

SINGLE PARAMETER MODELS: 15 Hours

Introduction to Probability, Priors and Posterior Analysis, Statistical Models, The Bayes inference. Bayes Rule, Normal model, Conjugate model, Binomial model, Posterior Distribution and Inferences. Markov Chain Monte Carlo simulation, RJags, The Metropolis-Hasting algorithm, Gibbs Sampler, Approximation based on posterior modes.

MULTI-PARAMETER AND HIERARCHICAL MODELS: 15 Hours

Multi-parameter -Normal data with non-informative, conjugate, and semi-conjugate prior distributions, Multivariate normal model, Hierarchical - Exchangeability and setting up, Computation. Bayesian Data Analysis: Model checking, Evaluating, comparing, and expanding models, modeling accounting for data collection, Decision analysis.

NON-LINEAR MODELS: 15 Hours

Mixture models- Setting up and interpreting mixture models, Gaussian process models Multivariate models- Non - normal models and multivariate regression surfaces. Comparison of Population: Inference for Proportions, Inference for Normal Populations, Rates and Sample Size Determination.

Total Hours	**45**

Text Books:

1.	Ronald Christensen, Wesley Johnson, Adam Branscum, Timothy E Hanson, “Bayesian Ideas and Data Analysis: An Introduction for Scientists and Statisticians”, CRC Press, 2019.
2.	Andrew Gelman, John B, Carlin, Chapman, “Bayesian Data Analysis”, Hall/CRC Publication, 2013.

Reference Books:

1.	Gelman, A., Carlin, J. B., Stern, H. S., Rubin, D. B, “Bayesian Data Analysis”, Third Edition, Chapman & Hall/CRC, 2018.

2.	Gill, Jeff, “Bayesian Methods: A Social and Behavioral Science Approach”, CRC. 3rd Edition, 2013.
3.	Peter D. Hoff, “A First Course in Bayesian Statistical Methods”, Springer, 2009.

Web References:

1.	https://towardsdatascience.com/the-gentlest-of-introductions-to-bayesian-data-analysis-74df448da25
2.	http://www.stat.columbia.edu/~gelman/presentations/bayes_lecture.pdf
3.	https://link.springer.com/article/10.3758/s13423-017-1272-1

Online Resources:

1.	https://www.coursera.org/learn/bayesian-statistics
2.	https://onlinecourses.swayam2.ac.in/imb21_mg03/preview
3.	https://www.cse.iitk.ac.in/users/piyush/courses/bml_winter17/bayesian_ml.html

Tentative Assessment Methods & Levels (based on Revised Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks: 20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C913.1	Understand	Assignment	5
C913.2, C913.5, C913.6	Apply	Quiz	5
C913.3, C913.4	Analyse	Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Revised Bloom’s Level	Continuous Assessment Theory			End Semester Examination (Theory) [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	10	10	10	10
Understand	60	10	20	20
Apply	30	20	40	40
Analyse	-	60	20	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C913.1	3	2	2		1								1	2	2
C913.2	3	2	2		2								2	1	1
C913.3	3	3	3	3	3								3	3	1
C913.4	3	1	2		1								1	1	1
C913.5	3	1	2	2	1								2	1	2
C913.6	3	2	2		2								1	1	1

20AD914	CLUSTER COMPUTING	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	To study the basic concepts of parallel computing.
2.	To learn the Implications of cluster computing in minimizing throughput in networks.
3.	To understand the Different types of clusters and its industrial impact.
4.	To expertise in managing cluster computing devices.
5.	To improvise the strategies adopted on clusters in order to optimize the efficiency.

Course Outcomes

Upon completion of the course, students shall have ability to

C914.1	Interpret the modalities of using parallel computing to achieve low-cost computation using clusters.	[U]
C914.2	Illustrate the functionality of cluster computing to replace high computing devices.	[U]
C914.3	Classify and categorize the network devices pertaining to connectivity of clusters.	[A]
C914.4	Choose the cluster architectures and configurations for high availability.	[AP]
C914.5	Utilize the cluster computing devices for load balancing and sharing.	[AP]
C914.6	Develop a strategy to ensure data consistency in clusters.	[AP]

Course Contents:

INTRODUCTION TO CLUSTER COMPUTING **15 Hours**

Cluster computing-Approaches to Parallel computing - Low-cost parallel computing using clusters-Definition of Architecture of cluster - Functionality of cluster - categories of cluster - Cluster Middleware - Levels and layers of single system image - Cluster Middleware design objectives - Resource management and scheduling - Cluster programming environment and tools - Early cluster architectures - High Throughput computing clusters - Condor.

NETWORKING, PROTOCOLS, I/O OF CLUSTERS **15 Hours**

Networks and Interconnection - Design issues in interconnection networking - Design Architecture general principles and trade-offs – HiPPI - ATM-Memory Channel - Gigabit Ethernet - Setup of simple cluster-Metaclusters - Administering Heterogeneous Clusters - Highly available clusters - Mission critical applications - Types of failures and Errors - High availability cluster architectures - Faults and Error Detection.

PROCESS SCHEDULING, LOAD BALANCING, DISTRIBUTED SHARED MEMORY **15 Hours**

Job Management System-Resource management System - Policies for resource Utilization - Scheduling Policies - Load Sharing and Load Balancing - strategies for Load Balancing - Issues in Distributed shared memory - Write synchronization for data consistency - Double Faulting - Issues in Network performance in distributed shared memory. **Case Study:** NanOS.

Total Hours	**45**

Text Books:

1.	C.S.R. Prabhu, “Grid and Cluster Computing”, PHI learning Pvt Ltd, 2010, New Delhi.

2.	Rajkumar Buyya, “High Performance cluster computing Architectures and Systems”, Volume 1, Pearson Education, 2012.
Reference Books:	
1.	Ananth Grama, Anshul Gupta, Vipin Kumar, “Introduction to Parallel Computing”, Second Edition, Pearson Education, 2015.
2.	Rajkumar Sharma, “Optimizing Cluster Computing”, Lambert Academic Publishing, 2016.
3.	W.P. Petersen, P. Arbenz, “Introduction to Parallel Computing”, Oxford Publishing House, 2019.
Web References:	
1.	https://www.tutorialspoint.com/what-is-cluster-computing
2.	https://www.geeksforgeeks.org/an-overview-of-cluster-computing/
Online Resources:	
1.	https://www.coursera.org/lecture/parallelism-ia/5-1-computing-clusters-uv0SK
2.	https://courseware.cutm.ac.in/courses/introduction-to-high-performance-computing/

Tentative Assessment Methods & Levels (based on Revised Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks: 20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C914.1	Understand	Online Quiz	5
C914.2, C914.3	Understand, Analyze	Online Quiz	5
C914.4, C914.5,C914.6	Apply	Assignment	10

Summative assessment based on Continuous and End Semester Examination

Revised Bloom’s Level	Continuous Assessment Theory			End Semester Examination (Theory) [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	10	20	10	10
Understand	80	40	40	30
Apply	10	20	30	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C914.1	2	3	2		2								1	1	1
C914.2	3	2	2		2								2	2	1
C914.3	3	3	3	3	3								2	2	1

C914.4	1	3	2		1							1	1	1
C914.5	2	1	2	2	3							2	1	1
C914.6		2	2		2							2	2	1

20AD915	BUSINESS INTELLIGENCE	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1	To learn the fundamentals of business intelligence.
2	To acquire knowledge in data integration.
3	To perform multi-dimensional data modelling.
4	To explore enterprise reporting.

Course Outcomes:

Upon completion of the course, students shall have ability to

C915.1	Recognize the needs of Business Intelligence.	[R]
C915.2	Understand the technology and processes associated with Business Intelligence Framework.	[U]
C915.3	Understanding the Data Warehouse implementation methodology, metrics to achieve business goal.	[U]
C915.4	Design an enterprise dashboard that depicts the key performance indicators which helps in decision making.	[AP]

Course Contents:

Introduction to Business Intelligence **15 hours**

Introduction to OLTP and OLAP, BI Definitions & Concepts, Business Applications of BI, BI Framework, Role of Data Warehousing in BI, BI Infrastructure Components - BI Process, BI Technology, BI Roles & Responsibilities.

Introduction to Data Integration and Multi-Dimensional Data Modeling **15 hours**

Concepts of data integration need and advantages of using data integration, introduction to common data integration approaches, introduction to Extraction Transformation Loading (ETL) using SSIS, Introduction to data quality, data profiling concepts and applications. Introduction to data and dimension modeling, multidimensional data model, ER Modeling vs. multi-dimensional modeling, concepts of dimensions, facts, cubes, attribute, hierarchies, star and snowflake schema, introduction to business metrics and KPIs, creating cubes using SSAS.

Basics of Enterprise Reporting **15 hours**

Introduction to enterprise reporting, concepts of dashboards, balanced scorecards, introduction to SSRS Architecture, enterprise reporting using SSRS**. Case Study:** A Comparative study of KPI dashboard tools.

Total Hours: 45

Text Books:

1	David Loshin, “Business Intelligence”, Morgan Kaufmann, 2nd Edition, 2012.
2	Mike Biere, “Business intelligence for the enterprise”, Prentice Hall Professional, 2003.
3	R.N.Prasad, SeemaAcharya, “Fundamentals of Business Analytics”, John Wiley & Sons, 2011.

Reference Books:

1	Larissa Terpeluk Moss, ShakuAtre, “Business intelligence roadmap”, Addison-Wesley Professional, 2003.
2	Cindi Howson, “Successful Business Intelligence: Secrets to making Killer BI Applications”, McGraw Hill Professional, 2013.
3	Brain Larson, “Delivering business intelligence with Microsoft SQL server”, 2008, McGraw Hill Professional, 2016.
4	Lynn Langit, “Foundations of SQL Server 2005 Business Intelligence”, Apress, 2007.
5	Stephen Few, Information dashboard design, O’Reilly, 2006.
6	Efraim Turban, Ramesh Sharda, DursunDelen, “Decision Support and Business Intelligence Systems”, 10th Edition, Pearson 2014.
Web References:	
1.	www.wipro.com/documents/resource-center/library/bidw_bilogistics.pdf
2.	https://en.wikipedia.org/wiki/Business_intelligence
3.	http://www.webopedia.com
4.	campusconnect.infosys.com/homedownloads/BI/Dashboard
Online Resources:	
1.	https://www.coursera.org/learn/business-intelligence-tools
2.	https://www.coursera.org/courses?query=business%20intelligence
3.	https://www.coursera.org/specializations/data-warehousing

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C915.1	Remember	Quiz	5
C915.2	Understand	Writing Skills	5
C915.3	Understand	Class Presentation	5
C915.4	Apply	Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination (50 marks)
	CIA 1(10)	CIA 2(10)	CIA 3(10)	
Remember	60	-	-	-
Understand	40	60	40	40
Apply	-	40	60	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment Total		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C915.1	3	3	3	2	2	2		2	2	2	2	2	2	3	3
C915.2	3	3	3	3	3	3		2	2	2	2	3	3	3	3
C915.3	3	3	3	3	3	3		2	3	2	2	3	2	2	2
C915.4	3	3	3	3	3	3		2	3	3	2	3	3	3	3

20AD916	SCALABLE SYSTEM FOR DATA SCIENCE	3/0/0/3
Nature of Course	C (Theory Concept)	
Prerequisites	Python for Data Science	

Course Objectives:

1	To study the fundamental Systems aspects of designing and using Big Data platforms.
2	To study the approaches and design patterns to translate existing data-intensive algorithms and analytics into these distributed programming abstractions.
3	To get exposure to scalable systems for data science applications.
4	To study the types of Big Data, Design goals of Big Data platforms.
5	To design and create small real time applications.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C916.1	Understand the basics of scalable systems.	[U]
C916.2	Understand the concepts of processing large volume of big data.	[U]
C916.3	Describe the attributes of big data storage systems.	[A]
C916.4	Create the understanding of machine learning over big data.	[AP]
C916.5	Apply their knowledge to design solutions to different problems.	[AP]

Course Contents:

MODULE I BIG DATA & DISTRIBUTED SYSTEMS **15 Hours**

Introduction to Big Data - Storage, compute, visualization, Files vs. Overview of Relational Databases vs. NoSQL Databases - Big Data systems: HBase/Big Table, Cassandra/Key-Value Store, Graph DB overview - Clusters, Cloud computing, Edge computing - Cloud storage.

MODULE II PROCESSING LARGE VOLUMES OF BIG DATA **15 Hours**

Big Data Processing with MapReduce and Spark - Spark Basics – RDD – transformations – action - Shuffle - Spark internals - Spark tuning – Google File System – Hadoop File System.

MODULE III MACHINE LEARNING AT SCALE **15 Hours**

ML over Big Data –TensorFlow - Parameter server and Federated learning - Spark ML for ML pipelines - **Case Study:** Scalable training and inferencing over graph neural networks, Scalable pattern mining and analysis over Twitter streams, Distributed video analytics over drone (Tello) video feeds.

Total Hours: 45

Text Books:

1	J. Leskovec, A. Rajaraman and JD Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2nd Edition, 2020.
2	Mahoney, Michael W. "Randomized algorithms for matrices and data - Foundations and Trends in Machine Learning”, 3rd Edition, 2011.

Reference Books:

1	Woodruff, David P, "Sketching as a tool for numerical linear algebra”, Foundations and Trends in Theoretical Computer Science, 2014.
2	Cathy O’Neil and Rachel Schutt, "Doing Data Science: Straight Talk from the Frontline", O’ Reilly, 2020.

Web References:

1	https://cds.iisc.ac.in/courses/ds256/
2	https://cds.iisc.ac.in/wp-content/uploads/DS256.2017.L1.Introduction.pdf

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C916.1 & C916.2	Understand	Quiz	5
C916.3 & C916.4	Analyze	Assignment	5
C916.5	Apply	Application - Poster Presentation	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	40	20	20	20
Apply	40	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C916.1	3	3	3	2	2	2		2	2	2	2	2	2	3	3
C916.2	3	3	3	3	3	3		2	2	2	2	3	3	3	3
C916.3	3	3	3	3	3	3		2	3	2	2	3	2	2	2
C916.4	3	3	3	3	3	3		2	3	3	2	3	3	3	3
C916.5	3	3	3	3	3	3		2	3	3	2	3	2	3	3

20AD917	WEB AND SOCIAL MEDIA MINING	3/0/0/3
Nature of Course	H (Theory Technology)	
Pre requisites	Data Warehousing and Mining	

Course Objectives:

1	To provide an overview of common text mining and social media data analytic activities.
2	To introduce the various tools for Text Mining and carry out Pattern Discovery, Predictive Modelling.
3	To understand the complexities of processing text and network data from different data sources.
4	To enable students to solve complex real-world problems for sentiment analysis and Recommendation systems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C917.1	Interpret the terminologies, metaphors and perspectives of social media analytics.	[U]
C917.2	Apply a wide range of classification, clustering, estimation and prediction algorithms on Textual data.	[AP]
C917.3	Perform social network analysis to identify important social actors, subgroups and network properties in social media sites.	[A]
C917.4	Provide solutions to the emerging problems with social media such as behaviour analytics and recommendation systems.	[A]
C917.5	Design new solutions to opinion extraction, sentiment classification and data summarization problems.	[AP]

Course Contents:

Module 1: Text and Web Mining: (18 Hours)

Text Representation- tokenization, stemming, stop words, TF-IDF, Feature Vector Representation, NER, Text Clustering, Text Classification, Topic Modelling, Query optimization, page ranking. Web Crawling- Crawler Algorithms, Implementation Issues, Evaluation, Session & visitor Analysis, Visitor Segmentation, Analysis of Sequential & Navigational Patterns, Predictions based on web user transactions.

Module 2: Social Media Mining (15 Hours)

Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization. **Making connections**: Link analysis. Random graphs and network evolution. **Social contexts**: Affiliation and identity; Social network analysis, Recommendation system

Module 3: Sentimental and Behavioural Analytics (12 Hours)

Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modelling; Sentiment Analysis; Sentiment Prediction. **Behaviour Analytics**: Individual Behaviour, Collective Behaviour.

Case study: Usage of Linguistic Inquiry and Word Count (LIWC) analysis software program and similar tools

Total Hours: 45

Text Books:

1.	Bing Liu, “Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data”, Springer, Second Edition, 2011.
2	Reza Zafarani, Mohammad Ali Abbasi and Huan Liu, “Social Media Mining – An Introduction”, Cambridge University Press, 2014.

Reference Books:

1.	Bing Liu, “Sentiment Analysis and Opinion Mining”, Morgan & Claypool Publishers, 2012.

2.	Nitin Indurkhya, Fred J Damerau, “Handbook of Natural Language Process”, 2nd Edition, CRC Press, 2010.
3.	Matthew A.Russell, “Mining the social web”, 2nd edition- O'Reilly Media, 2013.
4.	Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, First Edition, 2009.
Web References:	
1.	https://www.g2.com/articles/social-media-data-mining
2.	www.gsb.stanford.edu/faculty-research/behavioral-lab
Online Resources:	
1.	https://www.coursera.org/projects/basic-sentiment-analysis-tensorflow
2.	https://cs.ccsu.edu/~markov/ccsu_courses/WebMining.html
3	https://www.coursera.org/learn/text-mining?specialization=data-mining

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C917.1 &2	Understanding	Assignment	10
C917.3&4	Analyze	Quiz	5
C917.5	Apply	Case Study	5

Assessment Methods & Levels (based on Blooms’ Taxonomy)				
Summative assessment based on Continuous and End Semester Examination				
Bloom’s Level	**Continuous Assessment**			**End Semester Examination Theory [50 marks]**
	Theory			
	CIA1 [10 marks]	**CIA2 [10 marks]**	**CIA3 [10 marks]**	
Remember	20	20	20	20
Understand	40	30	20	30
Apply	40	50	60	50
Analyse	-	-	-	
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment Total**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C917.1	3	3	3	2	2	2		2	2	2	2	2			
C917.2	3	3	3	3	3	3		2	2	2	2	3			
C917.3	3	3	3	3	3	3		2	3	2	2	3			
C917.4	3	3	3	3	3	3		2	3	3	2	3			
C917.5	3	3	3	3	3	3		2	3	3	2	3			

20AD918	GAME THEORY FOR DATA SCIENCE	3/0/0/3

Nature of Course	C (Theory Concept)
Pre requisites	Nil

Course Objectives:

1	To familiarize with the process of game with perfect information.
2	To identify logic and strategic decision making involved in the games.
3	To outline rational behavior in strategically interdependent situations of games.
4	To get subsequent understanding of game design and development.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C918.1	Describe the basic knowledge of dominant strategy equilibrium, pure and mixed strategy Nash equilibrium.	[R]
C918.2	Recognize the strategic games with perfect information.	[U]
C918.3	Illustrate the concepts of extensive games with different illustrations.	[AP]
C918.4	Estimate all possible outcomes, while making decision with imperfect information.	[AP]
C918.5	Analyze the repeated games with imperfect information and its applications.	[AP]

Course Contents:

MODULE I Introduction to Games with Perfect Information 15 Hours

Introduction, Nash Equilibrium: Theory - Nash Equilibrium: Illustrations - Mixed Strategy Equilibrium: Strategic games in which players may randomize- Mixed strategy Nash equilibrium- Dominated actions- Equilibrium in a single population. **Case studies:** Expert diagnosis and Reporting a crime, Social psychology and game theory.

MODULE II Extensive Games with Perfect Information 15 Hours

Introduction - Strategies and outcomes - Nash equilibrium - Sub game perfect equilibrium - Backward induction - the ultimatum game and the holdup game - Stackelberg's model of duopoly - Illustration: entry into a monopolized industry - Electoral competition with strategic voters.

Case studies: Committee decision-making - Exit from a declining industry - Coalitional Games and the Core.

MODULE III Game with Imperfect Information, variants and Extensions 15 Hours

Bayesian Games - Strictly Competitive Games and Maxminimization - Repeated games: The Prisoner's Dilemma and General Results - Bargaining. **Case studies and Applications:** Oligopoly in Water Management - A Forestry Management Problem. Human–Environment–Social System and Evolutionary Game Theory - Mine craft - Google's sponsored search – eBay auctions – K-armed bandits.

Total Hours:	**45**

Text Books:

1	Martin Osborne, "An Introduction to Game Theory", Oxford University Press, 2012.
2	Matsumoto, Akio and Szidarovszky, Ference, "Game Theory and its Applications", McGraw Hill Education (India) Private Ltd., 2016.
3	Jun Tanimoto, "Fundamentals of Evolutionary Game Theory and its Applications", ublished by Springer Japan, 2016.

Reference Books:

1	Hans Peters, "Game Theory – A Multi – Leveled Approach",'Second Edition. Published by springer – verlag Berlin Heidelberg., 2016.
2	Steven Tadelis, "Game Theory An Introduction", Princeton University Press, Princeton and Oxford,2013.
3	Avinash dixit and Susan Skeath, "Games of Strategy", Fourth International Student Edition,

	2015.
4	Leyton –Brown.k, Shoham, Y, “Essentials of Game Theory: A Concise”, Multidisciplinary Introduction’, Morgan & Claypool Publishers.2010.
Web References:	
1	https://www.economics.utoronto.ca/osborne/igt/
2	http://nptel.ac.in/syllabus/110104063/
3	www.cs.stanford.edu
4	https://www.eurosis.org/cms/?q=node/61
Online Resources:	
1	https://www.edx.org/course/advanced-algorithmics-and-graph-theory-with-python?index=product&queryID=ab92be263c9a6348326bbe065a44f27a&position=2
2	https://www.coursera.org/learn/game-theory-1
3	https://www.edx.org/xseries/lasallex-introduction-to-game-design?index=product&queryID=357872364171401627 2be15a6ac7b84a&position=1

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C918.1, C918.2	Understand	Online Quiz	5
C918.3, C918.4	Apply	Presentation	5
C918.4, C918.5	Analyze	Assignment	5
C918.5	Analyze	Case study	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyze	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C918.1	3	3	3	3	2	2	2		2	1			3	3	3
C918.2	3	3	3	3	2	2	2		2	1		1	3	3	3
C918.3	3	3	3	3	2	2	2		2	1		1	3	2	2
C918.4	3	3	3	3	2	2	2		2	1		1	3	2	2
C918.5	3	3	3	2	2	2	2		2	1		1	3	2	2

20AD919	EDGE COMPUTING	3/0/0/3
Nature of Course	H (Theory Technology)	
Pre requisites	Cloud Computing	
Course Objectives:		
1.	To understand about edge and fog computing.	
2.	To analyze the usage of integrating IoT, fog, cloud	
3.	To apply the edge computing	
4.	To learn the intricacies about big data	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C919.1	Recall the technologies in IoT and usage of Edge Computing.	[R]
C919.2	Illustrate various edge devices and their ecosystems, issues and challenges.	[U]
C919.3	Develop edge-based distributed computing platforms.	[AP]
C919.4	Develop and Implement Internet of Things (IoT) applications through fog computing architecture.	[AP]
C919.5	Analyze the performance of the applications developed using fog, edge model.	[A]
C919.6	Infer knowledge in Fog computing and big data.	[U]

Course Contents:

Introduction to Edge and Fog Computing: 15 hours

Internet of Things (IoT) and new computing paradigms, Fog computing: A platform for Internet of Things and analytics, Emergence of edge computing, Legal aspects of operating IoT applications in the fog. Edge Architecture, Multi-Tier cloud computing framework; Data services with clouds at home; Leveraging mobile devices to provide cloud service at the edge.

Networking for Edge and Fog Computing: 15 Hours

Integrating IoT + Fog + Cloud Infrastructures: System modeling and research Challenges, Management and Orchestration of network slices in 5G, Fog, Edge, and Clouds. System Design- Optimization problems in fog and edge computing, Middleware for fog and edge Computing: Design issues, A Lightweight container middleware for edge cloud architectures.

Data Processing: **15 Hours**

Data management in fog computing, Predictive analysis to support fog application deployment, using machine learning for protecting the security and privacy of Internet of Things (IoT) systems, fog Computing realization for Big data analytics, Case Study- Edge analytics in Irrigation System, Smart surveillance video stream processing at the edge for real-time human objects tracking.

	Total Hours	**45**

Text Books:	
1.	R. Buyya, S.N. Srirama, “Fog and Edge Computing: Principles and Paradigms”, Wiley-Blackwell,Wiley, 2019
2	Perry Lea, “IoT and Edge Computing for Architects”, Second Edition, Packt Publishing, 2020.

Reference Books:	
1.	David Jensen, "Beginning Azure IoT Edge Computing", Apress publication 2019 Edition.
2.	Deepak Gupta, "Emerging Trends and Roles of Fog, Edge and Pervasive Computing in Intelligent IoT Driven Applications", Publisher: Wiley-IEEE Press, 2020
Web References:	
1.	https://hortonworks.com
2.	https://www.cloudera.com/about.html.
3.	https://www.javatpoint.com/what-is-edge-computing
4.	https://www.educba.com/what-is-edge-computing/
Online Resources:	
1.	https://www.udemy.com/topic/internet-of-things/
2.	https://www.udemy.com/course/introduction-to-edge-computing/
3.	https://www.coursera.org/lecture/technologies-and-platforms-for-artificial-intelligence/computing-anywhere-iot-and-edge-for-ai-DoG2L

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks: 20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C919.3	Apply	Quiz	5
C919.4	Apply	Assignment	5
C919.5	Analyze	Assignment	10

Summative assessment based on Continuous and End Semester Examination

Revised Bloom's Level	Continuous Assessment – Theory			End Semester Examination (Theory) [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	-	-	-	-
Understand	-	20	20	20
Apply	60	50	40	40
Analyse	40	30	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C919.1	3	3	2	2	2	-	-	-	-	-	2	2	2	3	3
C919.2	3	3	3	3	2	-	-	-	-	-	2	3	3	3	2
C919.3	3	3	2	2	2	3	1	-	-	-	2	2	3	2	2
C919.4	3	3	3	3	3	2	1	-	-	-	2	3	2	2	3
C919.5	3	3	2	2	3	2	-	-	2	-	2	2	3	3	2
C919.6	3	3	3	3	3	-	-	-	2	-	3	2	3	2	2

20AD920	REINFORCEMENT LEARNING	3/0/0/3

Nature of Course	D (Theory Application)
Pre requisites	Artificial Intelligence

Course Objectives:

1	To understand the concepts of reinforcement learning, Multi Armed bandits problem, Finite Markov Decision Process.
2	To provide approximate solutions methods for Reinforcement learning.
3	To get familiarize with applications and case studies of reinforcement learning.
4	To demonstrate on various methods of learning like Dynamic programming, Monte Carlo methods and Temporal-Difference Learning.
5	To excel with Tabular Methods and Prediction with Approximation.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C920.1	Discuss the Reinforcement Learning primitives used for solving problems.	[U]
C920.2	Analyze the problems using Finite Markov Decision process and dynamic program.	[AP]
C920.3	Apply Monte Carlo, Temporal Difference methods for policy evaluation and prediction.	[AP]
C920.4	Analyze the Tabular Methods and On-policy Prediction with Approximation.	[AP]
C920.5	Develop an Intelligent system for the real time problems using RL.	[AP]

Course Contents:

MODULE I REINFORCEMENT LEARNING PRIMITIVES 15 Hours

Introduction and Basics of RL, Defining RL Framework, Probability Basics: Probability Axioms, Random Variables, Probability Mass Function, Probability Density Function, Cumulative Distribution Function and Expectation. Introduction to Agents, Intelligent Agents – Problem Solving – Searching, Logical Agents.

MODULE II DECISION PROCESS AND PROGRAMMING 15 Hours

Finite Markov Decision Process: Basics, The Agent-Environment Interface, Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks, Policies and Value Functions, Optimal Policies and optimal Value Functions, Optimality and Approximation. **Dynamic Programming:** Definition, Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous dynamic programming, Generalized Policy Iteration, Efficiency of dynamic Programming. **Monte Carlo Methods:** Definition, Monte Carlo Prediction, Monte Carlo Estimation of Action values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy prediction via Importance Sampling, Incremental implementation

MODULE III TD METHOD AND POLICY GRADIENTS 15 Hours

Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), SARSA: On-policy TD control, Q-learning Off-policy TD control. **Policy Gradients:** Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

Total Hours:	**45**

Text Books:

1	Richard S. Sutton and Andrew G. Barto,"Reinforcement Learning: An Introduction", 2nd Edition

Reference Books:	
1	Daniel Jurafsky & James H Martin, “Speech and Natural Language Processing”, Pearson Publications.
2	Alberto Leon-Garcia, "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition.
Web References:	
1	http://www.cse.iitm.ac.in/~ravi/courses/Reinforcement%20Learning.html
2	http://cse.iitkgp.ac.in/~adas/courses/rl_aut2021/syllabus.html
Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc20_cs74/preview
2	https://www.coursera.org/specializations/reinforcement-learning

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C920.1, C920.3	Apply	Quiz	5
C920.2, C920.4	Apply	Assignment	10
C920.5	Analyze	Demonstration	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C920.1	3	3	3	3	3	2			2	2		2	3	2	2
C920.2	3	3	3	3	3	2	2		2	2		2	3	2	2
C920.3	3	3	3	3	2	2	2		2	2		2	3	2	2
C920.4	3	3	3	3	3	2	2		2	2		2	3	3	3
C920.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

20AD921	PROJECT MANAGEMENT AND FINANCE	3/0/0/3

Nature of Course	Theory

Course Objectives:

1	To facilitate the students to understand the importance of project management, project planning and implementation
2	To provide an in-depth knowledge about important facets of projects and the methods of project evaluation
3	To make the students understand the different project planning and scheduling techniques
4	To familiarize the students with contract management and to impart knowledge on effective project implementation in them
5	To understand the knowledge of finance

Course Outcomes:

Upon completion of the course, students shall have ability to:

C921.1	Evaluate projects and assess their feasibility	[U]
C921.2	Plan and schedule project activities for implementation	[AP]
C921.3	Monitor and control project implementation	[U]
C921.4	Identify deviations and take corrective measures in implementing projects	[U]
C921.5	Analyze the implications of applying knowledge representation in Finance	[A]

Course Contents:

INTRODUCTION, PROJECT APPRAISAL **15 Hours**

Project Management - Need for project management - Benefits - Project Management Lifecycles - Project management Functions - Project Initiation – Project Planning - Project Selection Methods - Project Execution - Project Portfolio Process - Project Closure - Project Manager - Roles and Responsibilities -Selection of Project Team- – Technical Appraisal – Commercial Appraisal – Economic Appraisal – Financial Appraisal – Management Appraisal - Project Cost Estimation – Order of magnitude estimate – Macro and micro estimating - Components of capital cost of a project

RISK MANAGEMENT, FINANCE AND SCHEDULING **15 Hours**

Project Financing – Sources of Finance – Life cycle costing concept - Project Risk Management - Steps in Risk Management - Risk Identification - Risk Analysis - Project Scheduling - Project Network Construction - CPM - PERT – Gantt Charts - Updating of network - Network Cost System - crashing of project network-Types of costs - Project Cost control – Crashing of Project Network – Resource Leveling – Resource Smoothing - Management of software's - Advantages of Using Project Management Software - Common Features - MS project and Primavera.

PURCHASING, CONTRACT MANAGEMENT, EVALUATION AND AUDIT **15 Hours**

Introduction - Purchase Cycle - Procurement Process - Contract Management - Contract Management framework - Principles of Project Contracts - Project Contracting Process - Legal Aspects of Project Management – Tenders - Global Tendering - Insurance for Projects – contracts - Project Evaluation – Evaluation objectives – Evaluation methods, Project Evaluation under uncertainty – Benefits and Challenges of Performance Measurement and Evaluation - Post Audit – Objectives of Post Audit – Phases of Post Audit – Types of Post Audit – Agencies for Post Audit of Govt./Govt. sponsored projects (Indian Scenario) - **Case study:** Social Cost Benefit Analysis - Emerging Trends.

Total Hours:	**45**

Text Books:

1	PMBOK Guide Seventh Edition, "A Guide to the Project Management Body of Knowledge" (2021)

2	Financial Management: Theory & Practice 14th Edition by Eugene F. Brigham and Michael C. Ehrhardt (2013).
3	Jack R Meredith and Samuel J Mantel (2011). Project Management - A Managerial Approach (8th ed), WileyIndia.
Reference Books:	
1	Jeffrey K Pinto (2016). Project Management, Achieving Competitive Advantage (1st ed), Pearson Education.
2	Nagarajan K (2017). Project Management (8th ed) New Age International (P) Ltd), New Delhi
3	Nicholas (2009). Project Management for Business and Technology (1st ed), Prentice Hall of India.
4	Bhavesh M Patel (2010). Project Management (1 st ed), Vikas Publishing House.
5	Gopalakrishnan and Rama Moorthy V E(2008). Text Book of Project Management (1st ed),Macmillan.
Web References:	
1	https://www.greycampus.com/opencampus/project-management-professional
2	https://preparepm.com/pmp/intro.html
3	https://www.thoughtco.com/pmp-practice-questions-4005393
4	https://www.examspm.com/2017/07/27/pmp-study-notes-pdf/
5	https://nptel.ac.in/courses/110104073/
6	https://www.justacademy.co/pmp-notes/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C921.1,C921.3,C921.4	Understand	Assignment	10
C921.2	Apply	Quiz	5
C921.5	Analyze	Case study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	10	-	-
Understand	50	40	20	20
Apply	30	50	30	30
Analyze	-	-	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C921.1	3	3	2	2	2	3	2	3	1	1	2	2	3	2	3
C921.2	3	3	3	3	2	3	2	3			2	2	3	2	2
C921.3	2	3	2	3	2	2	2	3	1	1	2	2	3	2	3
C921.4	3	3	3	2	3	3	3	3			2	2	3	2	2
C921.5	3	3	3	3	2	2	3	3			2	3	3	2	3

20AD922	INTRODUCTION TO BRAIN AND NEUROSCIENCE	3/0/0/3
Nature of Course:	F (Theory)	
Pre requisites:	Nil	

Course Objectives:

1	**To provide students with broad knowledge of the field of neuroscience.**
2	To synthesize knowledge of the discipline of neuroscience.
3	Demonstrate a broad foundation in the concepts and methodologies of the interdisciplinary field of neuroscience.
4	To describe the functions of the brain and contribution of the nervous system.

Course Outcomes:
Upon completion of the course, students shall have ability to

C922.1	Understand the function of the Nervous system at various levels.	[U]
C922.2	Analyze neuroscience nature and computation.	[AN]
C922.3	Interpret and report nervous system techniques.	[U]
C922.4	Analyze brain at the behavioral level of analysis.	[AN]
C922.5	Apply and integrate to other areas of study.	[AP]

Course Contents:

Module I **15 hours**

Introduction to neuroscience – Cells of the Nervous system - Building a Brain: Development - Organization of the Nervous System - The senses - Outline of neuroanatomy – Role of experiments and computation in neuroscience; Methods in neuroscience; The interdisciplinary nature of neuroscience

Module II **15 hours**

Neural Systems: Organization of the vertebrate brain - Development of the Nervous system- Neurogenesis, migration, Axon path finding ,Role of neural activity in development –eye-hearing-olfaction.

Module III **15 hours**

Brain and behavior: Brain – Organization of the brain and its function - Behavior and cognition; Systems : Motor, sensory and learning; Regions; Networks; Neuron; Ion channels. **Case Study:** Medical Diagnosis.

Total Hours: 45

Text Books:

1.	Johs Hopkins,UPen, “Nuroscience”, MIT, Fourth Edition, 2015.
2.	Bob Garrett, Gerald Hough, “Brain and Behavior: An introduction to Behavioral Neuroscience”, Fifth Edition, 2017.

Reference Books:

1.	Eric R Kandel, James H Schwartz, “Principles of Neural Science”, Stanford, UCSF, Columbia, 2018.
2.	Charles A Nelson, “Brain, Mind and Behavior”, Macmillan Learning, 2006.

Web References:

1.	https://en.wikipedia.org/wiki/Neuroscience

2.	https://en.wiktionary.org/wiki/neurosystem
3.	https://psychology.fas.harvard.edu/cognition-brain-behavior
Online Resources:	
1.	https://onlinelibrary.wiley.com/journal/21579032
2.	https://open.bu.edu/handle/2144/27397

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C922.1 and C922.2	Understanding	Assignment	10
C922.3 and C922.4	Analyze	Quiz	5
C922.5	Apply	Case Study	5

Assessment Methods & Levels (based on Blooms' Taxonomy)				
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination Theory [50 marks]**
	Theory			
	CIA1 [10 marks]	**CIA2 [10 marks]**	**CIA3 [10 marks]**	
Remember	20			
Understand	40	20	20	20
Apply	40	30	20	30
Analyse	-	50	60	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment Total**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C922.1	3	3										2			2
C922.2	2	2	3									2			2
C922.3	2	3	2									2			2
C922.4	2	3	3									3			2
C922.5	3	2										3			3

20AD923	INTELLIGENT MULTI AGENT AND EXPERT SYSTEMS	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Artificial Intelligence Principles and Techniques

Course Objectives:

1	To understand the technicalities of Multi - agents.
2	To understand techniques of computing solutions on various forms of games.
3	To learn sequential action games and representations.
4	To gain the knowledge on relating AI and expert systems.
5	To learn the basics on expert system tools.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C923.1	Classify different types of multi-agent systems.	A
C923.2	Apply the agent concept in a distributed computing game environment.	AP
C923.3	Design and use appropriate representation scaling for agent communication.	AP
C923.4	Understands the conceptual and technical foundation of expert systems.	U
C923.5	Build complex computational and socio-technical systems using expert systems.	AP

Course Contents:

INTRODUCTION

Multiagent Systems and Distributed AI - Characteristics of Multiagent Systems- Applications - Applications - Rational Agent: Agents as Rational Decision Makers - Observable Worlds and the Markov Property - Observable Worlds and the Markov Property - Partial Observability - Self-Interested Agents-Mechanism Design Problem.

AGENT ARCHITECTURE AND COMMUNICATION

Intelligent Agent - Multiagent organization-Agent Communication - Negotiation and Bargaining - Trust and Reputation in multiagent systems - Distributed cognitive abilities - programming multiagent system-specification and verification - Logics for multiagent

EXPERT SYSTEMS AND TOOLS

Expert systems and AI – Production rules and interface: Knowledge representation – Interference in production systems – Pattern recognition and production rules – Tools for knowledge and interference inspection: User interface and explanation – User interface in PROLOG – Rule models.

Total Hours:	**45**

Text Books:

1	A Concise Introduction to Multiagent Systems and Distributed Artificial Intelligence,Nikos Vlassis,Morgan & Claypool Publishers, 2007.
2	Multiagent Systems,By Maria Alpers, Herbert Voges, Gerhard,MIT PRESS, 2016
3	Principles of Expert Systems, Peter J.F. Lucas & Linda C. van der Gaag, 2017.

References:

1	Expert Systems: Principles and Programming with CD By Joseph C. Giarratano, 2019.
2	Multiagent Systems Algorithmic, Game-Theoretic, and Logical Foundations By Yoav Shoham, Kevin Leyton-Brown, 2009.

Web References:

1	https://www.turing.ac.uk/research/interest-groups/multi-agent-systems
2	https://www.ias.ac.in/article/fulltext/reso/003/03/0046-0058

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C923.1,C923.2	Understand	Quiz	5
C923.3	Analyze	Assignment	5
C923.4,C923.5	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C923.1	2	2	2	1	1							2	2	2	2
C923.2	3	2	2	3	2							2	2	2	2
C923.3	3	2	2	2	1							2	2	2	2
C923.4	2	2	2	2	2							2	2	3	3
C923.5	3	3	2	2	1							3	3	2	2

20AD924	DATA SCIENCE APPLICATIONS OF NLP	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Data Science

Course Objectives:

1	Understand NLP and its classifications
2	Learn to use various classification models
3	Understand the usage of Graphs and Trees structures in NLP
4	Able to train various word representations and variables
5	Learn to propose extension of existing NLP techniques for solving a range of problems.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C924.1	Describe the fundamental concepts and techniques of natural language processing.	U
C924.2	Distinguish among the various techniques, taking into account the assumptions, strengths, and weaknesses of each.	R
C924.3	Analyze the syntax, semantics, and pragmatics of a statement written in a natural language.	A
C924.4	Develop speech-based applications that use speech analysis (phonetics, speech recognition, and synthesis).	AP
C924.5	Analyze large volume text data generated from a range of real-world applications.	A

Course Contents:

INTRODUCTION AND CLASSIFICATION **15 Hours**

Introduction: Natural language processing and its neighbours - Three themes in natural language processing: Learning and knowledge, Search and learning Relational, compositional, and distributional perspectives, Linear text classification: The bag of words- Naive Bayes - Discriminative learning - Loss functions and large-margin classification - Logistic regression – Optimization, Nonlinear classification: Feed forward neural networks - Designing neural networks - Learning neural networks - Convolutional neural networks

REPRESENTATION LEARNING **15 Hours**

Representation learning: Recurrent Neural Network – Neural attention – Representing graphs – Representing Trees – Analysis Representation, Neural Structure Prediction: Local graph based models- Local transition based models – Global structured models, Pre-training transfer models: Neural language models and word embedding, Contextualized word representations – Transfer learning, Deep latent variable models: Categorical latent variables, Structured latent variables.

APPLICATIONS **15 Hours**

Information extraction: Entities-Relations- Events- Hedges, denials, and hypotheticals - Question answering and machine reading , Machine translation: Machine translation as a task - Statistical machine translation - Neural machine translation - Decoding-Training towards the evaluation metric , Text generation: Data-to-text generation - Text-to-text generation - Dialogue

Total Hours:	**45**

Text Books:

1	Natural Language Processing, Jacob Eisenstein, 2018.
2	Natural Language Processing – A Machine Learning Perspective, Yue Zhang, Zhiyang Teng, Cambridge University Press, 2021

Reference Books:

1	Handbook of Natural Language Processing Second Edition, Chapman & Hall/CRC, Machine Learning & Pattern Recognition Series.
Web References:	
1	https://keras.io/examples/nlp/

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C924.1,C924.2	Understand	Quiz	5
C924.3	Analyze	Assignment	5
C924.4,C924.5	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C924.1	3	3	3	2	3	2						2	2	2	2
C924.2	3	3	3	2	3	2						2	2	2	2
C924.3	3	3	3	3	3	2						2	2	2	2
C924.4	3	3	3	2	3	2						2	2	3	3
C924.5	3	3	3	3	3	3						3	3	2	2

20AD925	FULL STACK WEB DEVELOPMENT	3/0/0/3
Nature of Course	F (Theory)	
Pre-Requisite	Object Oriented Programming using Java	

Course Objectives:

1	To learn the need of HTML and CSS Box Model.
2	To learn the Lifecycle of ReactJS and Type Conversion in JavaScript.
3	To learn the Node js Console & Node js Modules.

Course Outcomes:

Upon completion of the course, students shall have ability to

C925.1	Understand the core concepts of HTML.	[U]
C925.2	Understand the concepts CSS Box Model.	[U]
C925.3	Apply various technique in JavaScript (internal and external)	[AP]
C925.4	Apply various Type Conversion in JavaScript	[AP]
C925.5	Represent Lifecycle of ReactJS	[AP]
C925.6	Analyse the Node js Console & Node js Modules	[A]

Course Contents:

Introduction to HTML **15 hours**

Introduction to HTML, Browsers and HTML, Editor's Offline and Online, Tags, Attribute and Elements, Doctype Element, Comments, Headings, Paragraphs, and Formatting Text, Lists and Links, Images and Tables Introduction CSS, Applying CSS to HTML, Selectors, Properties and Values, CSS Colors and Backgrounds, CSS Box Model, CSS Margins, Padding, and Borders, CSS Text and Font Properties, CSS General Topics

JavaScript **15 hours**

Introduction to JavaScript, Applying JavaScript (internal and external), Understanding JS Syntax, Introduction to Document and Window Object, Variables and Operators, Data Types and Num Type Conversion, Math and String Manipulation, Objects and Arrays, Date and Time, Conditional Statements, Switch Case, Looping in JS, Functions

ReactJS & NodeJS **15 hours**

Introduction, Templating using JSX, Components, State and Props, Lifecycle of Components, Rendering List and Portals, Error Handling, Routers, Redux and Redux Saga Immutable.js, Service Side Rendering, Unit Testing, Webpack Node js Overview, Node js - Basics and Setup, Node js Console, Node js Command Utilities, Node js Modules

Total Hours:	**45**

Text Books:

1	The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of

	a Modern Full Stack Web Developer ”Chris Northwood” APRESS; 1st edition (1 January 2018)
2	Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, Python, Django, and Docker ”Frank Zammetti” A Press; 2nd ed. edition (15 November 2022)
Reference Books:	
1	Full Stack Web Development For Beginners: Learn Ecommerce Web Development Using HTML5, CSS3, Bootstrap, JavaScript, MySQL, and PHP “Riaz Ahmed”
2	JavaScript from Beginner to Professional ” Rob Percival and Laurence Lars Svekis”
Web References:	
1	https://www.simplilearn.com/skills-required-to-become-a-full-stack-developer-article
2	https://www.udemy.com/course/the-full-stack-web-development/
3	https://careerfoundry.com/en/blog/web-development/what-is-a-full-stack-web-developer/
Online Resources:	
1	https://www.geeksforgeeks.org/what-is-full-stack-development/
2	https://www.w3schools.com/whatis/whatis_fullstack.asp

Assessment Methods & Levels (based on Blooms’Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C925.1,C925.2	Understand	Quiz	5
C925.6	Analyze	Assignment	5
C925.3,C925.4, C925.5	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination				
Bloom’s Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C925.1	3	3	3	2	3	2						2	2	2	2
C925.2	3	3	3	2	3	2						2	2	2	2
C925.3	3	3	3	3	3	2						2	2	2	2
C925.4	3	3	3	2	3	2						2	2	3	3
C925.5	3	3	3	3	3	3						3	3	2	2
C925.6	3	3	3	3	3	3						3	3	2	2

20AD926	AI FOR CYBER SECURITY	3/0/0/3
Nature of Course	F (Theory)	
Pre-Requisite	Nil	

Course Objectives:

1	To learn the need of AI for Cyber Security
2	To learn the detection of DDOS using AI techniques
3	To learn the intrusion detection using Neural Networks
4	To learn the various applications of AI to detect cyber attacks

Course Outcomes:

Upon completion of the course, students shall have ability to

C926.1	Understand the core concepts of AI for Cyber Security.	[U]
C926.2	Understand the concepts DDOS using AI techniques.	[U]
C926.3	Apply various AI techniques in Detection of malicious web pages	[AP]
C926.4	Apply various Context based Malicious event detection	[AP]
C926.5	Represent Architecture of IDS based on Neural networks	[AP]
C926.6	Analyse the Naive Bayes theorem to detect spam	[A]

Course Contents:

Fundamentals of AI & DDoS : 15 hours

Introduction – Problems that AI Solves – Why AI in Cyber security – Current Cyber Security Solutions - Structured data, Unstructured data – Supervised learning – Unsupervised learning – Reinforcement learning – classification problem - clustering problems – SVM – ANNs. Time series – Types of Time series – Time Series analysis in Cyber Security – Detecting DDOS with Time Series – Predicting DDOS attacks – Ensemble Techniques for Cyber security – Types of Ensemble – Types of Ensemble Algorithms – Bagging, Boosting, Stacking, Bayesian Model -Ensemble Method to detect Cyber attack.URL Blacklisting – Drive by download URL

Detection of malicious web pages, URLs: 15 hours

Command and Control URLs – Phishing URLs – Using Heuristics to detect Malicious Pages – Data for the analysis – Feature Extraction – Lexical Features –Web Content based Features – Host based features – site Popularity features. Using AI to crack CAPTCHA – Types of CAPTCHA – ReCAPTCHA – Breaking a CAPTCHA – Solving CAPTCHA with neural network - Machine Learning in Scan Detection - Machine-Learning Applications in Scan Detection. Context based Malicious event detection – Adware – Bots –Bugs – Ransomeware – Rootkit – Spyware – Trojan horses – Viruses – Worms – Malicious Injections in Wireless networks.

IDS & Mail Server 15 hours

Architecture of IDS based on Neural networks – Intelligent flow based IDS - Multi-Agent IDS – AI based Ensemble IDS – Machine Learning in Hybrid Intrusion Detection Systems - Machine-Learning Applications in Hybrid Intrusion Detection: Anomaly - Misuse Sequence Detection System - Parallel Detection System. Types of Mail Server – Data Collection from mail server – Naive Bayes theorem to detect spam – Laplace smoothing – Featurization Techniques to covert text based emails to numeric values – Logistic regression to spam filters - Anomaly detection techniques for SMTP and HTTP.	
Total Hours:	**45**

Text Books:	
1	Hands-On Machine Learning for Cyber Security: Safeguard your system by making your machine intelligence using the python ecosystem, Soma Harder, Sinan Ozdemir, Packt Publishing Ltd, 2018.
2	The state of the Art in Intrusion Detection System, Al-Sakib Khan Pathan, CRC Press, Taylor & Francis Group, 2014
3	Data Mining and Machine Learning in Cyber Security, Sumeet Dua and Xian Du, CRC Press, 2011.
Reference Books:	
1	Cybersecurity for Dummies, Brian Underdahl, Wiley, 2011
2	Cryptography and Network security, Behrouz A. Forouzan , Debdeep Mukhopadhyay, Mcgraw Hill Education, 2nd Edition, 2011
Web References:	
1	https://www.javatpoint.com/what-is-cyber-security
2	https://www.cisco.com/c/en_in/products/security/what-is-cybersecurity.html
3	https://www.ibm.com/in-en/topics/cybersecurity
Online Resources:	
1	https://us-cert.cisa.gov/ncas/tips/ST04-001
2	https://www.edureka.co/blog/what-is-cybersecurity/
3	https://www.microsoft.com/en-us/security/business/security-101/what-is-cybersecurity

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C926.1, C926.2	Understand	Quiz	5
C926.3	Analyze	Assignment	5
C926.4,C926.5	Apply	Tool based Assignment	10
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment(30)**		**End Semester**

	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	Examination [50 marks]
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C926.1	3	3	3	2	3	2						2	2	2	2
C926.2	3	3	3	2	3	2						2	2	2	2
C926.3	3	3	3	3	3	2						2	2	2	2
C926.4	3	3	3	2	3	2						2	2	3	3
C926.5	3	3	3	3	3	3						3	3	2	2

20AD927	QUANTUM ARTIFICIAL INTELLIGENCE	3/0/0/3

Nature of Course	G (Theory analytical)
Prerequisites	Machine Learning

Course Objectives:

1	To understand how the physical nature, as described by quantum physics, can lead to algorithms that imitate human behavior
2	To explore possibilities for the realization of artificial intelligence by means of quantum computation
3	To learn computational algorithms as described by quantum computation
4	Demonstrate the principles of quantum computer
5	To understand the knowledge about the applications on quantum annealing computer

Course Outcomes:

Upon completion of the course, students shall have ability to:

C927.1	Understand the computation with Qubits	[U]
C927.2	Apply Quantum algorithms - Fourier Transform and Grover's amplification	[AP]
C927.3	Apply Quantum problem solving using tree search	[AP]
C927.4	Understand and explore the models of Quantum Computer and Quantum Simulation tools	[U]
C927.5	Explore open source Quantum computer libraries for applications	[A]

Course Contents:

Introduction **15 Hours**

Introduction - artificial intelligence - computation - Cantor's diagonal argument - complexity theory - Decision problems - P and NP - Church–Turing Thesis - Von Neumann architecture - Problem Solving -Rules - Logic-based operators - Frames - Categorical representation - Binary vector representation - Production System - Deduction systems - Reaction systems - Conflict resolution - Human problem solving - Information and measurement - Reversible Computation - Reversible circuits Toffoli gate.

Quantum Algorithms **15 Hours**

Quantum physics - Unitary Evolution - Quantum Mechanics - Hilbert space – Quantum Time Evolution - Von Neumann Entropy - Measurement - Heisenberg's uncertainty principle -Randomness - Computation with Qubits - Computation with m Qubit - Matrix Representation of Serial and Parallel Operations - Quantum Boolean Circuits - Periodicity - Quantum Fourier Transform – Unitary Transforms - Search and Quantum Oracle - Grover's Amplification – Circuit Representation - Speeding up the Traveling Salesman Problem - The Generate-and-Test Method Quantum Problem-Solving - Heuristic Search - Quantum Tree Search - Tarrataca's Quantum Production System.

Quantum Implementation **15 Hours**

A General Model of a Quantum Computer - Cognitive architecture - Representation – Quantum Cognition - Decision making - Unpacking Effects - Quantum walk on a graph - Quantum annealing - Optimization problems - Quantum Neural Computation - Applications on Quantum annealing Computer – **Case Study**: Development libraries - Quantum Computer simulation tool kits.

Total Hours:	**45**

Text Books:

1	Andreas Wichert, Principles of Quantum Artificial Intelligence, First edition, World Scientific Publishing, 2014
2	Peter Wittek, Quantum Machine Learning, First edition, Academic Press, 2014
Reference Books:	
1	Andreas Wichert, Principles of Quantum Artificial Intelligence, Kindle Edition, 2013.
2	Maria Schuld , Francesco Petruccione, Machine Learning with Quantum Computers, Springer Cham, 2014.
Web References:	
1	https://www.edx.org/course/quantum-machine-learning
2	https://www.coursera.org/learn/introduction-to-quantum-information

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C927.1,C927.3,C927.4	Understand	Assignment	10
C927.2	Apply	Quiz	5
C927.5	Analyze	Case study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	10	-	-
Understand	50	40	20	20
Apply	30	50	30	30
Analyze	-	-	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C927.1	2	1	3		3								3	3	3
C927.2	3	3	2	3	2								3	2	3
C927.3	3	3	2										3		3
C927.4	2	1	2										2		2
C927.5	2	1	2	3				1	1	1	1	1	3	3	3

20AD928	ADVANCED DATABASE TECHNOLOGY AND DESIGN	3/0/0/3

Nature of Course	G (Theory analytical)
Pre-Requisite	DBMS

Course Objectives:

1	To understand the database system, data models, database languages.
2	To appraise different normalization techniques for efficient database design.
3	To acquire knowledge on parallel and distributed databases.
4	Demonstrate the principles of object oriented databases and XML databases
5	To understand the knowledge about the various intelligent databases.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C928.1	Identify the appropriate database models for any application.	[U]
C928.2	Design an efficient relational database system with optimal query processing.	[AP]
C928.3	Design parallel and distributed databases.	[AP]
C928.4	Interpret the real world data using object oriented databases and XML databases.	[AP]
C928.5	Analyze the various intelligent databases.	[A]

Course Contents:

Introduction and data models **15 Hours**

Database systems architecture, Data models - Entity-Relationship model, ER diagram notation, examples - Reduction of ER model to relational schema - Relational Mode - Fundamentals of SQL- Domains and Integrity constraints - Views – Triggers - Procedures and functions – Embedded and Dynamic SQL - Query processing and optimization -Normalization and relational database design.

Advanced databases **15 Hours**

Centralized and Client-Server Architectures – Parallel Systems – Distributed Systems – Parallel Databases – I/O Parallelism – Inter- and Intra-Query Parallelism – Inter and Intra operation - Parallelism – Distributed Database concepts – Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing. XML Databases - XML Data Model – DTD – XML Schema – XML Querying-Object oriented database concepts- Object Oriented Languages -ODMG Model and object relational databases.

Intelligent Databases **15 Hours**

Introduction: Active and deductive databases - Temporal and Spatial databases – Mobile databases - **Case Study:** Multimedia databases – In-memory database - NoSQL databases.

Total Hours:	**45**

Text Books:

1	Abraham Silberschatz, Henry F. Korth and S. Sudarshan, “Database System Concepts”, Sixth Edition, McGraw-Hill, 2011.
2	Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2016.
3	C.J.Date, A.Kannan, S.Swamynathan ,“An Introduction to Database System”, Eighth Edition, Pearson education, 2006.
4	Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, ”Advanced Database Systems”, Morgan Kaufmann publishers, 2006.

Reference Books:

1	Rob, Carlos Coronel, “Database Systems – Design, Implementation and Management”, 9th Edition, Thomson Learning, 2009.
2	Ramakrishnan, Johannes Gehrke,”Database Management Systems”, Third Edition, Mc.Graw Hill, 2014.
3	Won Kim, MIT Press, “Introduction to Object Oriented Databases”, MIT Press, 2003.
4	Subramanian, “Principles of Multimedia Database Systems”, Harcourt India Pvt Ltd., 2001.
Web References:	
1	http://users.sdsc.edu/~ludaesch/Paper/moc98.pdf
2	dzone.com/articles/what-an-in-memory-database-is-and-how-it-persists
3	https://www.sql.org/

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C928.1,C928.3,C928.4	Understand	Assignment	10
C928.2	Apply	Quiz	5
C928.5	Analyze	Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	10	-	-
Understand	50	40	20	20
Apply	30	50	30	30
Analyze	-	-	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C928.1	3	1			1					1		1	2		1
C928.2	3	3	3	3					2	2		3	3	2	2
C928.3	3	3	2	1					2	1	2	3	3	2	2
C928.4	3	3	2	2	2				2	1	2	2	3	2	2
C928.5	3	2	2		2				1	2	2	3	2	2	2

20AD929	KNOWLEDGE REPRESENTATION AND REASONING	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Nil

Course Objectives:

1	To understand the fundamentals of a knowledge based system.
2	To learn and use syntax with semantics in knowledge representation.
3	To explore production system and inheritance.
4	To impart knowledge in defaults and action.
5	To understand the knowledge representation in various applications.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C929.1	Understand the fundamental principles of logic-based Knowledge Representation	[U]
C929.2	Apply the production rule to solve real world problem	[AP]
C929.3	Explain the types of inheritance used in knowledge representation	[U]
C929.4	Recognize answer set programming and planning agents	[U]
C929.5	Analyze the implications of applying knowledge representation in AI systems	[A]

Course Contents:

Introduction

Knowledge-Based Systems - The Role of Logic - Syntax - Semantics-Pragmatics-Explicit and Implicit Belief- Expressing Knowledge-Resolution- Reasoning with Horn Clauses.

Production Systems and Inheritance

Production Systems: Basic Operation - Working Memory - Production Rules-Object-Oriented Representation-Structured Descriptions-Inheritance: Strict Inheritance and Defeasible Inheritance.

Defaults and Actions

Defaults :Closed-World Reasoning-Circumscription- Default Logic- Autoepistemic Logic. Actions - Answer-Set Programming Paradigm - Planning Agents.

Case Study : Knowledge Representation in Applications - Cognitive Robotics , Multi Agent Systems.

Total Hours:	**45**

Text Books:

1	Ronald J. Brachman,Hector J. Levesque,"Knowledge Representation And Reasoning",2004.
2	Michael Gelfond, Yulia Kahl, "Knowledge Representation, Reasoning, And The Design Of Intelligent Agents",Cambridge University Press,2014.

Reference Books:

1	Frank van Harmelen,Vladimir Lifschitz,Bruce Porter,"Handbook of Knowledge Representation",2008.

Web References:

1	https://in.coursera.org/lecture/chronic-pain/2-knowledge-representation-and-framing-hzrKA
2	https://nptel.ac.in/courses/106106140

Assessment Methods & Levels (based on Blooms'Taxonomy)
Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C929.1,C929.3,C929.4	Understand	Assignment	10
C929.2	Apply	Quiz	5
C929.5	Analyze	Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	10	-	-
Understand	50	40	20	20
Apply	30	50	30	30
Analyze	-	-	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C929.1	2	2	2								2	2	3	2	2
C929.2	2	2	2								2	2	3	2	2
C929.3	2	2	2								2	2	3	2	2
C929.4	3	3	3								2	2	3	2	2
C929.5	3	3	3								2	3	3	2	2

20AD930	DATABASE SECURITY AND AUDITING	3/0/0/3
Nature of Course	F (Theory)	
Pre-Requisite	DBMS	

Course Objectives:

1	To learn concepts of Databases Security & Control Flow Mechanisms.
2	To learn concepts of Security Software Design.
3	To learn concepts of Database Protection & Intrusion Detection Systems.
4	To learn Architecture of IDES System.
5	To learn concepts of SORION Model for the Protection of Object-Oriented Databases.

Course Outcomes:

Upon completion of the course, students shall have ability to

C930.1	Understand the core concepts of Databases Security.	[U]
C930.2	Recognize the perceptions Control Flow Mechanisms.	[U]
C930.3	Apply various Security Software Design in Database Security.	[AP]
C930.4	Apply various Database Protection & Intrusion Detection Systems.	[AP]
C930.5	Represent Architecture of IDES System.	[AP]
C930.6	Analyse the SORION Model for the Protection of Object-Oriented Databases	[A]

Course Contents:

Introduction to Databases Security **15 hours**

Introduction to Databases Security Problems in Databases Security Controls Conclusions Security Models - Introduction Access Matrix Model Take-Grant Model Acten Model PN Model Hartson and Hsiao's Model Fernandez's Model Bussolati and Martella's Model for Distributed databases Security Models - Bell and LaPadula's Model, Biba's Model, Dion's Model, Sea View Model, Jajodia and Sandhu's Model. The Lattice Model for the Flow Control conclusion, Security Mechanisms. Introduction User Identification/Authentication Memory Protection, Resource Protection, Control Flow Mechanisms, Isolation Security Functionalities in Some Operating Systems, Trusted Computer System Evaluation Criteria

Security Software Design **15 hours**

Security Software Design Introduction a Methodological Approach to Security Software Design Secure Operating System Design Secure DBMS Design Security Packages Database Security Design Statistical Database Protection & Intrusion Detection Systems Introduction Statistics Concepts and Definitions Types of Attacks Inference Controls Evaluation Criteria for Control Comparison. Introduction IDES System RETISS System ASES System Discovery

Database Systems and Auditing **15 hours**

Models For the Protection of New Generation Database Systems - Introduction A Model for the Protection of Frame Based Systems A Model for the Protection of Object-Oriented Systems SORION Model for the Protection of Object-Oriented Databases, Auditing, Auditing Types and

Records, Statement Auditing, Privilege Auditing, Schema Object Auditing, Fine-Grained Auditing, Focusing Statement, Privilege, and Schema Object Auditing, Auditing in a Multitier Environment.	
Total Hours:	**45**

Text Books:	
1	Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2020.
2	Database Security, Castano, Second edition, Pearson Education, 2011.
Reference Books:	
1	Database security by alfred basta, melissa zgola, CENGAGE learning, 2011.
Web References:	
1	https://www.utc.edu/engineering-and-computer-science/caecd/course-listing/cpsc-670
2	https://castle.eiu.edu/pingliu/tec5363/syllabus/tec5363syllabus.html
Online Resources:	
1	http://biet.ac.in/pdfs/DATABASE%20SECURITY.pdf
2	https://www.infosecinstitute.com/skills/learning-paths/database-security/
3	https://www.iisecurity.in/courses/database-security-course.php

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C930.1, C930.2	Understand	Quiz	5
C930.3	Analyze	Assignment	5
C930.4,C930.5	Apply	Tool based Assignment	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	40	40	40
Apply	60	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C930.1	3	3	3	2	3	2						2	2	2	2
C930.2	3	3	3	2	3	2						2	2	2	2
C930.3	3	3	3	3	3	2						2	2	2	2
C930.4	3	3	3	2	3	2						2	2	3	3
C930.5	3	3	3	3	3	3						3	3	2	2

20AD007	AUTONOMOUS SYSTEMS AND DRONES	3/0/0/3
Nature of Course	D (Theory Application)	
Prerequisites	Nil	

Course Objectives:

1	To gain insight into the basic elements of drone systems used in civilian missions.
2	To introduce unmanned aerial systems (UAS) including drones and autonomous unmanned aerial vehicles (UAV) with sensors.
3	To Understand the regulatory procedures of drones, pilot certification and licensing and basic safety measures required of UAS / UAV.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C007.1	Understand the evolution and classification of Drones / Unmanned aerial Vehicle (UAVs).	[U]
C007.2	Illustrate the commercial applications used by various types of drones.	[A]
C007.3	Gain knowledge on UAVs technology side of things (sensors, platforms, navigation, power source, communication, range, altitude and speed).	[AP]
C007.4	Apply their knowledge in different types of flight controllers.	[AP]

Course Contents:

MODULE I UNMANNED AERIAL VEHICLE (UAVs) 15 Hours

UAV Classifications – Review of few Successful UAVs – Design Project Planning – Feasibility Analysis Design Process – UAV Conceptual Design – UAV Preliminary Design – UAV Detail Design – Design Review, Evaluation, Feedback – UAV Design Steps, Overview of Commercial Drones and Kits.

MODULE II DRONES 15 Hours

History of Autonomous Flights – Principles of Flight – Flight Maneuvers – Showcase of DIY drones, Critical Technologies – Navigation, Sensors and Payloads, Power Sources, Communications – COTS Drone Technologies, Airframe - Building the Little Dipper Airframe – Step by step build instructions – Power Train – Propellers – Motors – Total Lift – Wrapping.

MODULE III CONTROLLERS 15 Hours

Flight Controller – Build Instructions of Flight Controller – GPS – Compass – Battery Monitor – Transmitter – Frequency Bands – Different Modes Around the World, Software Monitoring and control – Popular Drone Cameras – FPV for Live stream – Key Flight Safety Rules – PreFlight Checklist and Flight Log information – Laws and Regulation.

Total Hours: 15

Text Books:

1	Terry Kilby and Belinda Kilby Make: Getting Started with Drones, First Edition, Maker Media Inc, San Francisco CA, 2018.
2	John Baichtal “Building your own Drones A beginners Guide to Drones, UAVs and ROVs”, Que Publishing 2018.

Reference Books:

1	Mohammad H. Sadraey “Design of Unmanned Aerial Systems” First Edition, John Wiley & Sons, Inc., USA 2020.
2	Make: Getting Started with Drones: Build and Customize Your Own Quadcopter, by Terry Kilby & Belinda Kilby 2015.

Web References:

1	https://www.coursera.org/learn/robotics-flight

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C007.1, C007.2 & C007.3	Understand	Quiz	5
C008.4 & C008.5	Analyze	Assignment	5
C008.6	Apply	Application - Poster Presentation	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	50	20	20	20
Understand	50	40	40	40
Apply	-	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C007.1	3	3	3	3	3	2			2	2		2	3	2	2
C007.2	3	3	3	3	3	2	2		2	2		2	3	2	2
C007.3	3	3	3	3	2	2	2		2	2		2	3	2	2
C007.4	3	3	3	3	3	2	2		2	2		2	3	3	3

20AD008	CRYPTO CURRENCIES	3/0/0/3

Nature of Course	C (Theory Concept)
Pre-Requisite	Nil

Prerequisites: Cryptography and Network Security

Course Objectives:

1	To explain the fundamental ideas of cryptocurrencies.
2	To explore the Blockchain concept and mining.
3	To examine the concept of distributed ledger and Bitcoin.
4	To discuss various aspects of Ethereum.
5	To understand legal issues of cryptocurrencies and associated security challenges.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C008.1	Discuss the fundamentals of cryptographic systems.	[U]
C008.2	Interpret the structure and implementation of the Blockchain.	[U]
C008.3	Describe the operation of Bitcoin.	[U]
C008.4	Apply mining strategies for implementation of cryptocurrencies.	[AP]
C008.5	Illustrate the legal issues of cryptocurrencies.	[AP]
C008.6	Articulate the security issues and challenges of cryptocurrencies.	[AP]

Course Contents:

MODULE I Fundamentals of Cryptography and Blockchain 15 Hours

Introduction to Cryptography & Cryptocurrencies: Cryptographic Hash Functions - Hash Pointers and Data Structures - Digital Signatures – Secret Key Encryption - public-key encryption - Public Keys as Identities - A Simple Cryptocurrency. **The Blockchain:** Introduction -Advantage over conventional distributed database - Blockchain Network- Mining Mechanism - Distributed Consensus Structure of a Block – Block Header – Block identifiers – The Genesis Block – Linking Blocks – Merkle Trees – Simplified Payment Verification.

MODULE II Cryptocurrencies 15 Hours

History - Distributed Ledger - Nakamoto consensus - Proof of Work- Proof of Stake - Proof of Burn – Introduction to Bitcoin - Transactions, Blocks, Mining, and the Blockchain - Bitcoin Transactions - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Altcoins.

MODULE III Real world Applications and Challenges 15 Hours

Legal aspects of virtual currency - Stockholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy - post-quantum cryptography - Segregated witness benefits – Mimblewimble - Bitcoin as a Platform – Append only log – Smart property – Security Principles – User Security best prctices. **Case Study:** pycoin.

Total Hours:	**45**

Text Books:

1	Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press; 2nd Ed.2019.
2	Mastering Bitcoin: Unlocking Digital Cryptocurrencies by Andreas M. Antonopoulos, 2nd Edition, O'Reilly Publishers, 2010.
3	Bitcoin, Blockchain, and Cryptoassets: A Comprehensive Introduction by Fabian Schär and Aleksander Berentsen, MIT Press, 2020.

Reference Books:

1	An Introduction to Cryptocurrencies - The Crypto Market Ecosystem by Nikos Daskalakis, Panagiotis Georgitseas, Routledge, 2020.
2	Fundamentals of Blockchain by Ravindhar Vadapalli, Blockchainprep, 2020.
3	Cryptography and Network Security: Principles and Practice by William Stallings, 7th Edition, Pearson education, 2017.
Web References:	
1	https://www.coursera.org/learn/crypto-finance
2	https://www.udemy.com/course/complete-course-on-blockchain-and-crypto-currency/
3	https://courses.dcxlearn.com/p/blockchain-and-cryptocurrency-the-basics
Online Resources:	
1	https://media2.mofo.com/documents/170900-understanding-blockchain-cryptocurrencies.pdf
2	https://scet.berkeley.edu/wp-content/uploads/BlockchainPaper.pdf
3	https://bitcoin.org/bitcoin.pdf

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C008.1, C008.2 & C008.3	Understand	Quiz	5
C008.4 & C008.5	Apply	Assignment	5
C008.6	Apply	Case Study Based Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	50	20	20	20
Understand	50	40	40	40
Apply	-	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C008.1	3	3	3	2	2								3		2
C008.2	3	3	3	2	2								3		2
C008.3	3	3	3	3	2								2		2
C008.4	3	3	3	2	2	2	2	2	2	2		2	2		2
C008.5	3	3	3	3	2	2	2	2	2	2		2	2	2	2
C008.6	3	3	3	3	2	2	2	2	2	2		2	2	2	2

20AD009	AI IN HEALTH CARE APPLICATIONS	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Artificial Intelligence Principles and Techniques

Course Objectives:

1	To Identify healthcare myths and digital transformation.
2	To gain knowledge in Precision Medicine and Intelligent Personal Health records.
3	To Understand AI Healthcare operations and Innovation.
4	To familiar with AIOps Strategy.
5	To analyze the future healthcare technologies.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C009.1	Understand about Health care myths and Digital Transformation.	[U]
C009.2	Recognize Health Records analytics.	[U]
C009.3	Identify the various healthcare operations.	[A]
C009.4	Develop an understanding in security services.	[A]
C009.5	Learn about telemedicine and their innovation.	[U]
C009.6	Apply principles and algorithms to evaluate a model.	[AP]

Course Contents:

MODULE I: INTRODUCTION **15 Hours**

AI health care myths - Human centered AI - Prescription for Personal Health - Ambient Computing Healthcare - Continuous monitoring using AI-Precision medicine -Intelligent Personal Health records - Digital Transformation.

MODULE II: AI HEALTHCARE OPERATIONS **15 Hours**

AIops strategy- Clinical Impact of AIops - Data Analytics and AI-Design and Innovation - AIops for Healthcare Delivery-AIOps for service performance - HIPAA, PH1, PII Protection - AIOps Usecase.

MODULE III: FUTURE OF HEALTHCARE **15 Hours**

Role of Medical Imaging Computing - AI in Radiology and Practical Use cases - Chronic Disease Management-AI Telemedicine - Telehealth Innovation-Digital Medication -Case Study: Cancer diagnostics and treatment decisions.

Total Hours:	**45**

Text Books:

1	Kerrie L. Holley, Siupo Becker, “AI -First Healthcare”, O'Reilly Media, Inc., 2018.
2	Adam Bohr, Kaveh Memarzadeh, “Artificial Intelligence in Healthcare”, Elsevier Science, 2020.

Reference Books:

1	Robert Shimonski, Robert Shimonski”, “How Artificial Intelligence Is Changing IT Operations and Infrastructure Services” , wiley, 2020.

Web References:

1	https://www.coursera.org/specializations/ai-healthcare
2	https://www.udemy.com/course/the-complete-healthcare-artificial-intelligence-course-2021

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C009.1, C009.2, C009.5	U	Quiz	5
C009.3, C009.4	A	Assignment	5
C009.6	AP	Developing a Model	10

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment(30)**			**End Semester Examination [50 marks]**
	CIA-1 [10 marks]	**CIA-2 [10 marks]**	**CIA-3 [10 marks]**	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	20	20	20	20
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	**Summative Assessment**		**Total**
	Continuous Assessment	**End Semester Examination**	
20	30	50	100

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C009.1		1	3	3	3							1	3	3	3
C009.2	1	2	3	3	3	1						1	3	3	3
C009.3	2	2	3	3	2							1	3	3	3
C009.4	2	1	3	3	3							1	3	3	3
C009.5	2	1	2	3	2	1						1	3	3	3
C009.6	3	3	3	3	2				2	2		1	3	3	3

20AD010	PREDICTIVE ANALYTICS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Machine Learning Techniques and Database Management Systems	

Course Objectives:

1.	To Develop skills to process and analyze complex data sets
2.	To learn, how to develop models to predict categorical and continuous outcomes, using techniques such as decision trees, logistic regression, random forest.
3.	To understand the different types of Data visualization, Distributions and summary statistics.
4.	To know the use of the binary classifier and numeric predictor nodes to automate model selection.
5.	To advice on when and how to use each model. Also learn how to combine two or more models to improve prediction

Course Outcomes

Upon completion of the course, students shall have ability to

C010.1	Illustrate the process to successfully design, build, evaluate and implement predictive models for a various business application.	[U]
C010.2	Select appropriate predictive modeling approaches to identify cases to progress with.	[R]
C010.3	Identify the real-world business problems and model with analytical solutions.	[AP]
C010.4	Apply predictive modeling approaches and evaluate the performance.	[AP]
C010.5	Convert any real-world decision-making problem to hypothesis and apply suitable statistical testing.	[A]

Course Contents:

PREDICTION AND CLASSIFICATION METHODS: 15 Hours

Explanatory vs Predictive Modeling – Multiple Linear Regression, Classification Tress, Avoiding Overfitting - Regression Trees, Improving Prediction: Random Forests and Boosted Trees, Logistic Regression, Discriminant Analysis.

MEDIA ANALYTICS: 15 Hours

Social Network Analytics - Directed vs. Undirected Networks - Visualizing and Analyzing Networks - Social Data Metrics and Taxonomy - Using Network Metrics in Prediction and Classification – Text Mining - Bag-of-Words vs. Meaning Extraction at Document Level – **Case Study:** Catalog Cross-Selling - Predicting Bankruptcy**.**

PERFORMANCE EVALUATION: 15 Hours

Evaluating Predictive Performance - Judging Classifier Performance - Judging Ranking Performance - Oversampling: Oversampling the Training Set, Evaluating Model Performance Using a Non-oversampled Validation Set.

Total Hours	**45**

Text Books:

1.	Jeffrey S. Strickland, “Predictive Analytics using R”, Lulu Publications, ISBN 978-1-312-84101-7, 2017.
2.	Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl, “Data mining for Business Analytic: Concepts, Techniques, And Applications In R”, Wiley Publications, 2018.

3.	Daniel T. Larose, Chantal D. Larose, “Data Mining and Predictive Analytic”, Wiley, 2nd Edition 2015.
4.	Dr. Anasse Bari, Mohamed Chaouchi, Tommy Jung, “Predictive Analytics For Dummies”, Wiley, 2nd Edition, 2016.
5.	Richard Hurley, “Predictive Analytics: The Secret to Predicting Future Events Using Big Data and Data Science Techniques Such as Data Mining, Predictive Modelling, Statistics, Data Analysis, and Machine Learning”, 10th Edition, Ationa Publications 2019.
Reference Books:	
1.	Dinov Ivo D., “Data Science and Predictive Analytics”, Springer International Publishing AG, 5th Edition, 2018.
2.	Tamhane Ajit C, “Predictive Analytics- Parametric Models for Regression and Classification Using R”, John Wiley & Sons Inc, 1st Edition, 2020.
3.	John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies”, The MIT Press, 1st Edition, 2015.
4.	G.James, D.Witten, T.Hastie, R.Tibshirani, “An introduction to statistical learning with applications in R” ,Springer,2013.
Web References:	
1.	https://www.ibm.com/in-en/analytics/predictive-analytics
2.	https://cloud.google.com/learn/what-is-predictive-analytics
3.	https://www.sas.com/en_in/insights/analytics/predictive-analytics.html
4.	https://www.mathworks.com/discovery/predictive-analytics.html
Online Resources:	
1.	https://www.edx.org/course/introduction-to-analytics-modeling
2.	https://www.ey.com/en_in/ey-faas-learning-solutions/certificate-in-predictive-analytics-in-python
3.	https://www.skillsoft.com/channel/predictive-analytics-84e64131-1557-11e7-9f21-659139b59eba
4.	https://intellipaat.com/data-analytics-master-training-course

Tentative Assessment Methods & Levels (based on Revised Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks: 20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C010.1, C010.2	Understand	Online Quiz	5
C010.3	Remember	Assignment	5
C010.4, C010.5	Apply	Assignment	5
C010.6	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Revised Bloom’s Level	Continuous Assessment			End Semester Examination (Theory) [50 marks]
	Theory			
	CIA-1	CIA-2	CIA-3	

	[10 marks]	[10 marks]	[10 marks]	
Remember	20	20	-	10
Understand	80	50	40	20
Apply	-	30	50	50
Analyse	-	-	10	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C010.1	2	3	1		1								1	2	2
C010.2	1	2	2		2								2	1	1
C010.3	3	3	3	3	3								3	3	1
C010.4	1	1	2		1								1	1	1
C010.5	2	1	2	2	1								2	1	2

20AD011	COMPUTER VISION	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Machine Learning	
Course Objectives:		
1.	To provide a glimpse of what computer vision is about and its applications.	
2.	To give an understanding of image processing for computer vision.	
3.	To develop an appreciation for various issues in the design of computer vision and object recognition systems	
4.	To focus on early processing of images and the determination of structure: edges, lines, shapes.	
5.	To provide the student with programming experience from implementing computer vision and object recognition applications.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C011.1	Understand major concepts and techniques in computer vision and image processing.	[U]
C011.2	Analyze and design a range of algorithms for image processing.	[A]
C011.3	Choose different feature extraction techniques for image analysis and recognition	[AP]
C011.4	Identify the different causes for image degradation and overview of image restoration techniques.	[AP]
C011.5	Examine and develop practical and innovative image processing and computer vision applications or systems.	[A]
C011.6	Relate and identify solutions to problems in computer vision.	[U]

Course Contents:

INTRODUCTION AND IMAGE FORMATION: 15 Hours

Computer vision Introduction, Computer Vision vs Image Processing Image Formation – Geometric primitives and transformations, 2D transformations,3D transformations, 3D rotations, 3D to 2D projections, Lens Distortion - Photometric image formation- Lightning, Reflectance and Shading, Optics-The digital camera – Sampling and Aliasing, Color, Compression. **Case Study:** Open CV

IMAGE PROCESSING AND RECIGNITION: 15 Hours

Point Operators – Transformations – Orthogonal, Euclidean, Affine and Projective, Linear Filtering, Non-linear Filtering, Bilateral Filtering Fourier Transforms,2D Fourier Transforms, Applications – Sharpening, blur and Noise Removal, Image Enhancement Restoration, Histogram Processing. Recognition – Instance Recognition, Image Classification, Object Detection, Face Detection, Pedestrian Detection, General Object Detection, Semantic Segmentation- Medical Image Segmentation, Intelligent Photo Editing.

FEATURE DETECTION AND MATCHING AND 3D MOTION 15 Hours

Points and Patches, Edges and Contours, Contour Tracking , lines and Vanishing Points.3D Vision and methods, Projection schemes, shape from shading, photometric stereo, shape from texture, shape from focus, active range finding, surface representations, point based representations, volumetric based representations, 3D object Detection.3D reconstruction,3D Scanning, Introduction to Motion, Triangulation, bundle adjustment, translational alignment, Parametric Motion, Spline based Motion , Optical Flow, layered motion. Case Study : Digital Heritage, 3D Model Capture

	Total Hours	**45**

Text Books:

1.	Richard Szeliski, "Computer Vision: Algorithms and Applications", The University Washington, 2nd Edition, Springer, 2022.
2.	D.L Baggio, “Mastering OpenCV with Practical Computer Vision Projects”, Packt Publishing, 2017.
3.	E.R Davies,” Computer and Machine Vision”, Fourth Edition, Academic Press, 2012.

Reference Books:

1.	Jan Erik Solem, “Programming Computer Vision with Python: Tools and algorithms for analyzing images”, O’Reilly Media, 2012.
2.	Simon J.D Prince, “Computer Vision: Models, Learning and Inference”, Cambridge University Press, 2012.

Web References:

1.	https://pyimagesearch.com/
2.	https://omscs.gatech.edu/cs-6476-computer-vision-course-videos
3.	http://www.cse.iitm.ac.in/~vplab/computer_vision.html

Online Resources:

1.	https://www.coursera.org/learn/computer-vision-basics
2.	https://onlinecourses.nptel.ac.in/noc20_cs88/preview
3.	https://cloudxlab.com/course/99/computer-vision

Tentative Assessment Methods & Levels (based on Revised Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks: 20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C011.1, C011.6	Understand	Assignment	10
C011.2, C011.3	Analyze, Apply	Online Quiz	5
C011.4, C011.5	Apply, Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Revised Bloom’s Level	Continuous Assessment			End Semester Examination (Theory) [50 marks]
	Theory			
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	30	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C011.1	3	3	3	3	2	2	2					3			
C011.2	3	3	3	2	2	2				2		2			
C011.3	3	3	3	2	3	2			2			2			
C011.4	3	3	3	2	2	2			2	2	2	3			
C011.5	3	3	3	2	3	2	2		2	2		2			
C011.6	3	3	3	2	3	2	2		2	2		2			

20AD012	DATA ENGINEERING ON GOOGLE CLOUD PLATFORM	3/0/0/3

Nature of Course	H (Theory Technology)
Pre- Requisite	Cloud Computing

Course Objectives:

1	To extract, load, Transform, clean and validating data on Google Cloud Platform.
2	To design pipelines and architectures for data processing
3	To create and maintain machine learning and statistical models
4	To analyze the basic proficiency with streaming data and cloud Dataflow

Course Outcomes:

Upon completion of the course, students shall have ability to:

C012.1	Design and build data processing systems on Google cloud platform.	[U]
C012.2	Process batch and streaming data by implementing data pipelines on cloud dataflow.	[A]
C012.3	Design business insights by monitoring processing resources	[AP]
C012.4	Analyze , Evaluate and Predict data dependencies using Machine Learning models	[A]
C012.5	Leverage unstructured data using ML APIs on cloud platform.	[C]

Course Contents:

MODULE I DESIGNING DATA PROCESSING SYSTEMS 15 Hours

Introduction to Data Engineering – Challenges - Storage Technologies - Technical aspects of Data- Types of structure – Schema Design Consideration - Cloud SQL- Cloud Spanner- Cloud Big table- Cloud Firestore – Big Query- Designing data Pipelines- Data Publishing and Visualization- Batch and Streaming data- Designing data processing solution – Infrastructure – Distributed Processing- Migrating a Data warehouse

MODULE II BUILDING SOLUTIONS WITH GCP COMPONENT 15 Hours

Building and Operationalizing Storage systems – Adjusting Processing Resources- Data Cleansing- Batch and streaming – Transformation- Data Acquisition and import - Introduction to DataProc - Building a datalake using DataProc clusters – Create and Execute jobs on a DataProc Clusters with Spark andML API – Ephemeral cluster using Cloud Composer and DataProc.

MODULE III BUILDING MACHINE LEARNING Models ON GCP 15 Hours

Deploying machine learning pipelines– MLAPIs–Ingesting appropriate data-Retraining of ML models- continuous evaluation- Measuring, Monitoring and troubleshooting ML models – Terminology- Impact of dependencies – Designing for security and compliance – Ensuring Scalabitiy, Efficiency, Fidelity and Portability –Case Study: Project Management in GCP.

Total Hours:	**45**

Text Books:

1	Dan Sullivan.”Professional Data Engineer study Guide:, June 2020,Wiley Publication,ISBN:9781119618430.
	Janani Ravi, “GCP: Complete Google Data Engineer and Cloud Architect Guide”, November 2020, Packt Publisher. ISBN: 9781788999519
2	Adi Wijaya, “Data Engineering with Google Cloud Platform: A practical guide to

	operationalizing scalable data analytics systems on GCP" , March 2022, Packt Publisher. ISBN: 9781800565067
Reference Books:	
1	Hardback, "Cloud Infrastructure and Services Participant Guide Volume 1 & 2", EMC Education Services, Oct 2011.
2	J. Rhoton, R Haukioja,"Cloud Computing Architected: Solution Design Handbook" (Recursive Press, 2011, ISBN 978-0-9563556-1-4)
Web References:	
1	https://google/google-gcp-pde-professional-data-engineer-certification-exam-syllabus
2	https://www.amazon.com/Data-Engineering-Google-Cloud-Platform/dp/1800561326?asin=1800561326&revisionId=&format=4&depth=1
3	https://www.udemy.com/course/data-engineering-on-google-cloud-platform/
4	https://www.roitraining.com/google-cloud-platform-training/google-cloud-platform-developer-qualification-workshop-cp300/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C012.1	Understand	Assignment	5
C012.2 & C012.3	Analyze	Case Study	5
C012.4 & C012.5	Create	Mini Project	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	-	-	-	-
Understand	20	20	20	20
Apply	30	30	30	30
Analyze	50	50	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C012.1	3	3	3	2				2	2			3	3	3	2
C012.2	3	3	2	2				3	3			3	3	3	2
C012.3	3	3	3	3	3	3	3	3	2	2	2	3	3	3	2
C012.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C012.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

20AD001	FUNDAMENTALS OF DATABASE SYSTEMS	2/0/2/3

Nature of Course	G (Theory Analytical)
Pre requisites	Nil

Course Objectives:

1	To discuss the fundamentals of data models to conceptualize and depict a database system using ER diagrams.
2	To illustrate the relational database implementation using SQL with effective relational database design concepts.
3	To employ the normalization concepts to improve the database design.
4	To explain the fundamental concepts of transaction processing concurrency control techniques and Database Security.
5	To introduce the concepts of other Databases and NoSQL.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C001.1	Distinguish database systems from file systems and describe data models and DBMS architecture.	[U]
C001.2	Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.	[AP]
C001.3	Apply different normal forms to retrieve the data efficiently by removing Anomalies.	[AP]
C001.4	Infer the basic database storage structures and access techniques.	[A]
C001.5	Examine the concepts of Transaction processing, concurrency locking protocols.	[A]
C001.6	Realize the basic concepts of NoSQL.	[U]

Course Contents:

MODULE I DATA MODELS AND SQL **15 Hours**

Introduction to Database – File System Vs Database system – Users - Data models: Hierarchical - Network - Object Oriented - Entity Relationship – Relational Data Models - Database System Architecture - Data Abstraction - Data Independence - Integrity Constraints - Concept of Relations - Schema-Instance distinction - Table and key definitions – Views - Relational Query Languages: DDL – DML – TCL - DCL – SQL - Embedded SQL - Introduction to NoSQL.

MODULE II RELATIONAL DATABASE DESIGN AND STORAGE STRUCTURE **15 Hours**

Relational Database Design – Principles of a good schema design-functional dependencies - Armstrong's axioms for FD's - definitions of 1NF - 2NF - 3NF- BCNF- 4NF - Data Storage and Indexes - file organizations - primary and secondary index structures - B+ trees index structures - Static and dynamic hashing Techniques.

MODULE III TRANSACTION PROCESSING AND SECURITY **15 Hours**

Transaction Processing - ACID property - Serializability of scheduling - Concurrency control : Lock based concurrency control – Timestamp Based Database recovery. Database Security: Authentication - Authorization and access control - **Case Study :** Web databases, Distributed databases – MongoDB

Total Hours: 45

Text Books:

1	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, 7thEdition, Tata McGraw Hill, March 2019.
2	Gupta G K, “Database Management Systems”, Tata McGraw Hill Education Private Limited,New Delhi, 2012.

Reference Books:

1	RamezElmasri, ShamkatB.Mavathe, ”Database Systems”, 6th Edition, Pearson Education,2013.
2	Michael McLaughlin, “Oracle Database 12c PL/SQL Programming”, Tata McGraw Hill Education Private Limited, New Delhi, 2014.
3	Gaurav Vaish, “Getting Started with NoSQL”, Packt Publishing, March 2013.
Web References:	
1	http://www.nptel.ac.in
2	http://www.sqlcourse.com
3	http://www.edureka.co/mongodb
4	https://alison.com/courses/IT-Management-Software-and-Databases
Online Sources:	
1	https://www.coursera.org/learn/database-management
2	https://www.udemy.com/database-management-system/
3	http://www.nptelvideos.in/2012/11/database-management-system.html

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C001.1, C001.2, C001.4	Apply	Quiz	5
C001.2, C001.3 , C001.4	Apply	Assignment	10
C001.5	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	30	20	20	20
Understand	30	40	20	20
Apply	40	40	40	40
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C001.1	2	2	2								2	2	2		2
C001.2	2	2	2								2	2	2		2
C001.3	2	2	2								2	2	2		2
C001.4	3	3	3								2	2	2		2
C001.5	3	3	3								2	3	3		2
C001.6	3	3	2								3	3	2		2

20AD002	INFORMATION RETRIEVAL TECHNIQUES	2/0/2/3

Nature of Course	F (Theory Programming)
Prerequisites	Nil

Course Objectives:

1	To understand the basics of Information Retrieval.
2	To understand data modelling and Retrieval Evaluation.
3	To develop the fundamental understanding of Classification and Clustering in Information Retrieval.
4	To apply the concepts of web retrieval and crawling for a search engine.
5	To learn different techniques of the recommender system.

Course Outcomes: Upon completion of the course, students shall have ability to:

C002.1	Use an open source search engine framework and explore its capabilities.	[U]
C002.2	Explain the foundations of information retrieval, design, analysis and implementation of IR systems.	[U]
C002.3	Apply appropriate methods of classification or clustering.	[AP]
C002.4	Explore the methods and techniques to classify text documents.	[A]
C002.5	Design and implement innovative features in a search engine.	[AP]
C002.6	Design and implement a recommender system.	[AP]

Course Contents:

MODULE I Introduction - IR, Modeling and Retrieval Evaluation **15 Hours**

Motivation - IR System Architecture - Retrieval Process - Web: Introduction and Characteristics - The Impact of The Web on IR - IR Versus Web Search -Challenges - Search Engines. Basic IR Models - Boolean Model - Vector Model - Probabilistic Model - Set Theoretic Models - Algebraic Models - Structured Text Retrieval Models - Models for Browsing - Retrieval Evaluation and Metrics - Precision and Recall - Reference Collection - User -based Evaluation - Relevance Feedback and Query Expansion - Explicit Relevance Feedback.

MODULE II Classification and Clustering **15 Hours**

A Characterization of Text Classification - Unsupervised Algorithms: Clustering - Naïve Text Classification - Supervised Algorithms - Decision Tree - K-NN Classifier - SVM Classifier - Feature Selection or Dimensionality Reduction - Evaluation metrics - Accuracy and Error - Organizing the classes - Indexing and Searching - Inverted Indexes - Sequential Searching - Multidimensional Indexing.

MODULE III Web Retrieval, Web Crawling and Recommender Systems **15 Hours**

The Web - Search Engine Architectures - Cluster based Architecture - Distributed Architectures - Search Engine Ranking - Link based Ranking - Evaluations - Search Engine User Interaction - Browsing - Applications of a Web Crawler - Taxonomy - Architecture and Implementation - Scheduling Algorithms - Evaluation. Recommender Systems Functions - Data and Knowledge Sources - Recommendation Techniques - Content based Recommender Systems - Collaborative Filtering - Matrix factorization models - Neighborhood models. Case Study: IR using Python - PyTerrier.

Total Hours:	**45**

Text Books:

1	Ricardo Baeza -Yates and Berthier Ribeiro-Neto, - Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books, 2011.
2	Ricci, F, Rokach, L. Shapira, B.Kantor, - Recommender Systems Handbookll, First Edition, 2011.

Reference Books:

1	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “Introduction to information Retrieval”, Cambridge university press, first south asian edition 2012.
2	Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, - Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010.
3	G. Salton and M. J. McGill, Introduction to Modern Information Retrieval, McGraw-Hill, 1983.
Web References:	
1	https://www.lisbdnetwork.com/online-information-retrieval-syste/
2	https://www.youtube.com/watch?v=McVpRWiAP2I&list=PLMyP8LIIL3ht_WV4EXjN-uD3EPEK3hlyu
3	https://www.youtube.com/watch?v=h9gpufJFF-0

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C002.1, C002.2, C002.4	Understand	Quiz	10
C002.3, C002.5, C002.6	Apply	Assignment + Smart Programming Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	20	20	20
Apply	60	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C002.1	3	3	3	2	2							2	3	3	2
C002.2	3	3	2	2	2							2	2	2	2
C002.3	3	3	3	3	2							2	2	2	3
C002.4	3	3	3	2	3							2	2	2	3
C002.5	3	3	3	3	2							2	2	2	2
C002.6	3	3	3	3	3							2	2	2	2

20AD003	MACHINE LEARNING ALGORITHMS IN PYTHON	2/0/2/3

Nature of Course	F (Theory Programming)
Prerequisites	Nil

Course Objectives:

1	Import and wrangle data using Python libraries and divide them into training and test datasets.
2	Data preprocessing techniques, Univariate and Multivariate analysis, Missing values and outlier treatment etc.
3	Implement various types of classification methods including SVM, Naive bayes, decision tree and random forest.
4	Interpret Unsupervised learning and learn to use clustering algorithms.
5	Build real-world solutions using MLP.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C003.1	Use python programming language to work with data and apply machine learning tools to it.	[AP]
C003.2	Appreciate the importance of visualization in the data analytics solution.	[A]
C003.3	Identify and apply the appropriate machine learning technique for classification, pattern recognition, optimization and decision problems.	[AP]
C003.4	Interpret the output and validity of a learning algorithm.	[A]
C003.5	Explain the operation of different unsupervised algorithms and their practical uses.	[AP]
C003.6	Be able to design and implement various machine learning algorithms in a range of real-world applications.	[AP]

Course Contents:

MODULE I MACHINE LEARNING BASICS AND DATA PREPROCESSING **15 Hours**

Basic Concepts – Need for Machine Learning- Challenges and Applications- Data Loading with NumPy and pandas- Data Preprocessing techniques – Data Feature selection- Data Visualization.

MODULE II SUPERVISED MACHINE LEARNING ALGORITHMS **15 Hours**

Classification and Regression- Naïve bayes- Decision trees- support vector machine (SVM) – Random forest- Linear Regression- Multiple Linear Regression-Logistic Regression.

MODULE III UNSUPERVISED LEARNING **15 Hours**

Clustering- Applications of clustering- Challenges in unsupervised learning- K-means Algorithm- Agglomerative clustering- DBSCAN- Mean shift Algorithms. **Case study:** Data Visualization for social media data.

Total Hours: 45

Text Books:

1	Andreas C. Müller, Sarah Guido, “Introduction to Machine learning with python”, Released October 2016, Publisher(s): O'Reilly Media, Inc., 2021.
2	Manaranjan Pradhan, U Dinesh Kumar,” Machine Learning using Python”, Wiley Publications., 2021.

Reference Books:

1	Ahmed Ph. Abbasi, “Python Machine Learning: Machine learning algorithms for beginners from scratch”, Kindle Edition, 2018.

2	Gopal Sakarkar, Gaurav Patil , Prateek Dutta, “Machine Learning Algorithms Using Python Programming”, Nova science publishers, 2021.
3	Sebastian Raschka , Vahid Mirjalili , “Python Machine Learning: Machine Learning and Deep Learning with Python”, scikit-learn, and TensorFlow 2, 3rd Edition, Kindle Edition,2019.
Web References:	
1	https://machinelearningmastery.com/machine-learning-with-python/
2	https://pub.towardsai.net/machine-learning-algorithms-for-beginners-with-python-code-examples-ml-19c6afd60daa

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C003.1, C003.2	Apply	Quiz	5
C003.3, C003.4, C003.5	Analyze	Assignment	5
C003.6	Apply	Smart Programming Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	40	40	40	40
Analyse	30	30	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C003.1	3	3	3	2	3							2	3	3	3
C003.2	3	3	3	2	3							2	3	3	3
C003.3	3	3	3	3	3							2	3	3	3
C003.4	3	3	3	2	3							2	3	3	3
C003.5	3	3	3	3	3							3	3	3	3
C003.6	3	3	3	3	3							2	3	3	3

20AD004	DATA VISUALIZATION USING R	2/0/2/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Nil

Course Objectives:

1	Understand the principles of data and graphic design.
2	Evaluate the credibility, ethics, and aesthetics of data visualizations.
3	Know how to evaluate and criticize data visualizations based on principles of analytic design.
4	Be in the position to explore and present their data with visual methods.
5	Importance of analytics and visualization in the era of data abundance.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C004.1	Use RStudio to develop, test, and execute R scripts.	[AP]
C004.2	Use RStudio to perform basic data analysis functions including Input/Output, basic Exploratory Data Analysis (EDA), and graphical output.	[AP]
C004.3	Understand which graphical formats are useful for which types of data and questions.	[AP]
C004.4	Share data and graphics in open forums.	[AP]
C004.5	Create well-designed data visualizations with appropriate tools.	[AP]
C004.6	Know how to construct compelling visualizations using the free statistics software R.	[AP]

Course Contents:

MODULE I INTRODUCTION TO R **15 Hours**

Introduction to R and R studio- Data Inputting in R- Functions and Programming in R – Data Manipulation in R - Statistical Modelling in R- Advanced Data handling - Combined and restructuring data frames.

MODULE II INTRODUCTION TO DATA VISUALIZATION **15 Hours**

Introduction to Data Visualization –principles of analytic design plotting techniques- gg plot- Bar charts- Histograms- pie chart – Multidimensional data- visualization relations between variables.

MODULE III BASIC PLOTS, MAPS, AND CUSTOMIZATION **15 Hours**

Scatter plot- Line plot- Box plots- Customize plots- Scatter plot matrices -Conditioning plots -Lattice graphs - Interaction plots - Themes and faceting- v2.2.3 - Maps with Leaflet. **Case study:** Data Visualization for covid-19 dataset.

Total Hours:	**45**

Text Books:

1	Hadley Wickham, Garrett Grolemund , “R for data science : Import, Tidy, Transform, Visualize, And Model Data”, O;reilly 2017.
2	Rajesh K Maurya , Swati R Maurya, “R Programming for Data Analytics & Visualization”, SYBGEN learning, 2021.

Reference Books:

1	Tony Fischetti, Brett Lantz, “R: Data Analysis and Visualization”, Packt Publishing, 2016.
2	Thomas Rahlf, “Data Visualisation with R”, Springer, 2019.
3	Claus O. Wilke, “Fundamentals of Data Visualization”, O’Reilly, 2019.

Web References:	
1	https://www.coursera.org/learn/data-visualization-r
2	https://slcladal.github.io/dviz.html

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C004.1, C004.2	Apply	Quiz	5
C004.3, C004.4, C004.5	Apply	Assignment	5
C004.6	Apply	Smart Programming Assignment	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	-	-	-	-
Understand	20	20	20	20
Apply	40	40	40	40
Analyse	40	40	40	40
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C004.1	3	3	3	2	3							2	3	3	3
C004.2	3	3	3	2	3							2	3	3	3
C004.3	3	3	3	3	3							2	3	3	3
C004.4	3	3	3	2	3							2	3	3	3
C004.5	3	3	3	3	3							3	3	3	3
C004.6	3	3	3	3	3							2	3	3	3

20AD005	INTRODUCTION TO DATA ANALYTICS	2/0/2/3
Nature of Course	F (Theory Programming)	
Pre requisites	Nil	

Course Objectives:

1	To explore the fundamental concepts of data analytics.
2	To Identify the different ways of data Analysis.
3	To analyze real world problems using R.
4	To demonstrate the big data frameworks.
5	To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C005.1	Interpret the basic concepts of data analytics.	[U]
C005.2	Identify the need of data analytical tools.	[U]
C005.3	Analyze the real-world data using statistical approaches.	[A]
C005.4	Examine the statistical methods for arvard g and storing data.	[AP]
C005.5	Apply the various data arvard g techniques.	[AP]
C005.6	Choose an appropriate framework to solve real world problems.	[AP]

Course Contents:

MODULE I INTRODUCTION TO DATA ANALYTICS **15 Hours**

Introduction to Data Analytics – Data Science – Fundamentals and Components – Introduction to Big Data-Challenges of Conventional Systems – Web Data – Evolution of Analytic Scalability – Data Analytic Tools: R, Tableau, RapidMiner and Power BI.

MODULE II DATA ANALYSIS USING STATISTICAL METHODS **15 Hours**

Statistical Methods: Regression modelling, Multivariate Analysis – Bayesian arvard g – Classification: SVM & Kernel Methods - Analysis of time series - Rule Induction – Neural networks – Fuzzy Logic – Stochastic search methods – **Case Study:** Data analysis using R.

MODULE III BIG DATA FRAMEWORKS **15 Hours**

Introduction to NoSQL – Aggregate Data Models. Hbase: Data Model and Implementations – Cassandra: Data Model – Hadoop Integration. Introduction to Pig Data Model. Hive: Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries.

Total Hours: 45

Text Books:

1.	Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, Wiley and SAS Business Series, 2015.
2.	Michael Berthold, David J. Hand, “Intelligent Data Analysis, Springer, Second Edition, 2014
3.	Raj Kamal, Preeti Saxena,” Big Data Analytics: Introduction to Hadoop, Spark, and Machine-Learning”, McGraw-Hill Education,2019

Reference Books:

1.	P. J. Sadalage and M. Fowler, “NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence”, Addison-Wesley Professional, 2012.
2.	Richard Cotton, “Learning R – A Step-by-step Function Guide to Data Analysis, O‘Reilly Media, 2013.
3	Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)”, John Wiley & Sons, 2015.

Web References:

1	https://bigdatauniversity.com/
2	http://www.statistics.com/data-analytics- courses

Online Resources:	
1.	https://www.coursera.org/learn/introduction-to-data-analytics#syllabus
2.	https://nptel.ac.in/courses/110/106/110106072/
3.	https://www.coursehero.com/search/results/999014172/f62ad66198bebc37a3/
4.	https://www.edx.org/course/subject/data-analysis- statistics
5.	https://www.coursera.org/browse/data-science/data- analysis?languages=en
6.	https://www.cse.iitm.ac.in/~ravi/courses/Introduction%20to%20Data%20Analytics.html

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C005.1, C005.2, C003.3	Understand	Quiz	5
C005.4, C005.5	Analyze	Assignment	5
C005.6	Apply	Case study	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment (30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	40	20	20	20
Understand	40	20	20	20
Apply	20	40	40	40
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C005.1	2	3	3	3	3							2	2	2	2
C005.2	3	3	3	3	3							2	2	2	2
C005.3	3	3	3	3	3							2	2	2	2
C005.4	3	3	3	3	3							2	2	3	3
C005.5	3	3	3	3	3							3	2	2	2
C005.6	3	3	3	3	3							2	3	3	3

20AD006	INTRODUCTION TO DEEP LEARNING	2/0/2/3

Nature of Course	H (Theory Technology)
Prerequisite	Nil

Course Objectives:

1	To explain the basic concepts of neural networks.
2	To discuss the fundamentals of deep networks.
3	To examine the major architectures in deep networks.
4	To demonstrate the applications of deep learning.
5	To Analyze, critique, and revise data visualizations

Course Outcomes:

Upon completion of the course, students shall have ability to:

C006.1	Describe the fundamentals of Neural networks.	[U]
C006.2	Distinguish neural and deep networks.	[U]
C006.3	Build Deep Learning models with Keras in TensorFlow.	[AP]
C006.4	Identify the appropriate deep network architecture for an application.	[AP]
C006.5	Apply various deep learning techniques to design efficient algorithms for real-world applications.	[AP]
C006.6	Analyze the performance of a deep learning network.	[A]

Course Contents:

Module I: Foundations of Neural Networks **15 Hours**

Neural Networks – Training Neural Networks – Activation Functions - Loss Functions – Hyper parameters. Supervised Learning and Unsupervised Learning. **Fundamentals of Deep Networks** – Introduction to Deep learning – Common Architectural Principles of Deep Networks – Building Blocks of Deep Networks.

Module II: Major Architectures of Deep Networks **15 Hours**

Unsupervised Pre-Trained Networks - Convolutional Neural Networks - Transfer learning Techniques - Recurrent Neural Networks - Stochastic Gradient Descent – Recursive Neural Networks, Long Short-Term Memory (LSTM) Networks - Introduction to Deep Learning Tools: TensorFlow, Keras.

Module III: Applications **15 Hours**

Object Detection – Automatic Image Captioning – Image generation with Generative adversarial networks – Video to Text with LSTM models – Attention models for Computer Vision – **Case Study:** Named Entity Recognition – Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks – Sentence Classification using Convolutional Neural Networks – Dialogue Generation with LSTMs.

Total Hours: 45

Text Books:

1	Adam Gibson, Josh Patterson, “Deep Learning, A Practitioner’s Approach”, O'Reilly Media, 2017.
2	Ian Good fellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2017.
3	Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
4	Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.

Reference Books:

1	Daniel Graupe, “Deep Learning Neural Networks: Design and Case Studies”, World Scientific Publishing ,2016.
2	Yu and Li Deng, “Deep Learning: Methods and Applications”, Now Publishers Inc,2014.
3	Zurada,J.M. “Introduction to Artificial Neural systems”, Jaico Publishing House,2012.
4	Giancarlo Zaccone , Md. RezaulKarim , Ahmed Menshawy, ”Deep Learning with tensorflow : Explore neural networks and build intelligent systems with Python", Packt Publisher, 2020.

5	Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.
Web References:	
1	http://deeplearning.cs.cmu.edu/
2	http://deeplearning.net/
Online Resources:	
1	http://nptel.ac.in/courses/
2	https://www.udacity.com/course/deep-learning--ud730
3	https://bigdatauniversity.com/courses/introduction-deep-learning/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C006.1, C006.2	Understand	Online Quiz	5
C006.3, C006.4, C006.5	Apply	Mini Project	10
C006.6	Analyze	Technical Presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment(30)			End Semester Examination [50 marks]
	CIA-1 [10 marks]	CIA-2 [10 marks]	CIA-3 [10 marks]	
Remember	20	20	20	20
Understand	20	40	20	20
Apply	60	40	40	40
Analyze	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Formative Assessment	Summative Assessment		Total
	Continuous Assessment	End Semester Examination	
20	30	50	100

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C006.1	3	3	3	2	3	2	2		2			2	2	2	2
C006.2	3	3	3	3	3	2	2		2			2	3	3	2
C006.3	3	3	3	3	3	3	3		3			3	3	3	3
C006.4	3	3	3	3	3	3	3		3	2		3	3	3	3
C006.5	3	3	3	3	3	3	3	2	3	2	2	3	3	3	3
C006.6	3	3	3	3	3	3	3	2	3	2	2	3	3	3	3

20MC101	INDUCTION PROGRAMME	1/0/0/0
Nature of Course	Induction Programme	
Pre requisites	Nil	

Course Objectives:

1.	To have broad understanding of society and relationships
2.	To nurture the character and fulfil one's responsibility as an engineer, a citizen and a human being
3.	To incorporate meta skills and values

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Explore academic interest and activities	[AP]
C101.2	Work for excellence	[AP]
C101.3	Promote bonding and give a broader view of life and character	[AP]

Course Contents:

PHYSICAL ACTIVITY: Research over the past years has shown Yoga to have stress-relieving powers on students, paving the way for improved academic performance with the practice of asanas, meditation and breathing exercises. To prove these words Yoga classes has been planned in this module.(CO mapping: C101.1, C101.2, C101.3)

CREATIVE ARTS (students can select any one of their choice): Cultural development supports students to understand, feel comfortable with, value and appreciate the potential enrichment of cultural diversity. They should challenge discrimination, whether based on cultural or racial difference. Students should experience cultural traditions embedded in arts, crafts, language, literature, theatre, song, music, dance, sport, Science, technology and travel. Students should develop an appreciation of beauty both in experiencing artistic expression and by exploring their own creative powers. To inculcate those skills they are given a chance to exhibit their talents through painting, sculpture, pottery, music, dance, craft making and so on. .(CO mapping: C101.1, C101.2, C101.3)

UNIVERSAL HUMAN VALUES: Moral development involves supporting students to make considered choices around their behaviour and the values that provide a framework for how they choose to live. Moral development is also learning about society's values, understanding the reasons for them, how they are derived and change;

and how disagreements are resolved. Students must consider the consequences of personal and societal decisions on the wider community – local and global- and on the environment and future generations. To acquire thisthe students are exposed to training to enhance their soft skills. .(CO mapping: C101.1, C101.2, C101.3)

LITERARY AND PROFICIENCY MODULES: Social development helps students to work effectively together, developing the inter-personal skills required to relate positively with their peers and people of all ages. Students must also understand how to participate productively in a diverse and plural society and learn about, and how to effectively engage with societal institutions and processes. They should understand that a person may have different roles and responsibilities within society. To reach this the following aspects are given in the form of Reading, writing, speaking – debate, role play etc.Communication and computer skills. (CO mapping: C101.1, C101.2, C101.3)

LECTURES BY EMINENT PEOPLE: Teaching with Lectures It is essential to see lectures as a means of helping students learn to think about the key concepts of a particular subject, rather than primarily as a means of transferring knowledge from instructor to student. During the induction period students will attend to Guest lectures by subject experts.(CO mapping: C101.1, C101.2, C101.3)

VISIT TO LOCAL AREAS: Traveling is in fact a way of learning to learn. You are out of your comfort zone and so you must learn to be able to adapt to a new learning environment in a very short time. It also helps in your overall learning as well. In the induction period students will be taken to different places near college to learn new things. Eg. Meditation centre/orphanage/Hospital. (CO mapping: C101.1, C101.2, C101.3)

FAMILIARIZATION TO DEPARTMENT/BRANCH INNOVATION: Hod's of different brancheswill present about their department followed by department visit to view various facilities available at their department, new innovations from students and faculties etc.(CO mapping: C101.1, C101.2, C101.3)

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C101.1						3	3	3	3	3	3	3			1
C101.2						3	3	3	3	3	3	3			1
C101.3						3	3	3	3	3	3	3			1

20MC102	ENVIRONMENTAL SCIENCES	2/0/0/0

Nature of Course	Theory Concept
Pre requisites	Basics in Environmental Studies

Course Objectives:

1	To learn the integrated themes on various natural resources.
2	To gain knowledge on the type of pollution and its control methods.
3	To have an awareness about the current environmental issues and the social problems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C102.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C102.2	Understand the importance of natural resources and conservation of biodiversity.	[U]
C102.3	Understand and analyze the impact of engineering solutions in a global and societal context.	[U]
C102.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C102.5	Apply the gained knowledge in various environmental issues and sustainable development.	[AP]

Course Contents:

Module 1: Natural Resources **10 Hours**

Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources-Use and exploitation, environmental effects of mining- case study–Food resources- World food problems, case study. Energy resources -Renewable and non-renewable energy sources Land resources- Soil erosion and desertification – Role of an individual in conservation of natural resources.

Module 2: Environmental Pollutions **10 Hours**

Definition – causes, effects and control measures of: a. Air pollution-Acid rain - Green house effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedyb. Water pollution c. Solid waste management-Recycling of plastics-Pyrolysis method- causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.

Module 3: Social issues and the Environment	**10 Hours**
Sustainable development-water conservation, rain water harvesting, E-Waste Management – Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard. HIV AIDS.	
Total Hours:	**30**

Text Books:	
1	Anubha Kaushik and C P Kaushik “Perspectives in Environmental Studies” 4th Edition, New age International (P) Limited, Publisher Reprint 2014. New Delhi
2	Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, Oxford University Press 2015.

Reference Books:	
1	Tyler Miller, Jr, “Environmental Science”, Brooks/Cole a part of Cengage Learning, 2014.
2	William Cunningham and Mary Cunningham, “Environmental Science”, 13th Edition, McGraw Hill,2015.
3	Gilbert M. Masters, “Introduction to Environmental Engineering and Science”, Third Edition, Pearson Education, 2014.

Web References:	
1	http://nptel.ac.in/courses/104103020/20
2	http://nptel.ac.in/courses/120108002
3	http://nptel.ac.in/courses/122106030
5	http://nptel.ac.in/courses/122102006/20

Online Resources:	
1	https://www.edx.org/course/subject/environmental-studies
2	www.environmentalscience.org

Assessment Methods & Levels (based on Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C102.1	Remember	Quiz	**5**
C102.2	Understand	Mini project based on environmental aspect	**15**
C102.3	Understand	Class Presentation	**10**
C102.4 C102.5	Apply	Group Assignment	**10**

Summative assessment based on Continuous Assessment	
Revised Bloom's Level	**Term End Assessment [100 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C102.1						2	2						2		
C102.2						2	2						2		
C102.3						2	2							2	
C102.4						3	3						2		
C102.5						3	3						2		

20MC103	SOFT SKILLS	2/0/0/0
Nature of Course:	Theory Concept	
Pre requisites:	Technical Communication Skills	

Course Objectives:

1.	To develop the students competency level and their capabilities.
2.	To teach the students to be effective in workplace and social environments.
3.	To create self confidence among the students and to resolve stress and conflict within themselves.
4.	To help the students to enhance their career skills by increasing their productivity and performances.
5.	To concentrate more on conversation skills, presentation skills, verbal ability, critical and creative thinking.

Course Outcomes:

Upon completion of the course, students shall have ability to

C103.1	Remember the principles of soft skills required for their profession.	[R]
C103.2	Understand the importance of Interpersonal communication Skills among individuals, groups and cultures.	[U]
C103.3	Apply verbal and non-verbal communication skills in corporate environment.	[AP]
C103.4	Analyse and apply creativity skills, critical thinking skills and problem solving skills.	[AN]
C103.5	Articulate oral and written messages in an appropriate and persuasive manner to suit specific purposes, audiences and contexts at work place.	[AP]
C103.6	Apply good teamwork skills and Leadership Skills	[AP]

Module 1: Professional Communication Skills **10 Hours**

Introduction to the Soft Skills, Performance Evaluation 1 –Significance of Soft Skills- Understanding the basic Communication Principles –Listening Skills- Listening Exercises- Speaking Skills- How to start and Sustain a Conversation- Speaking in Groups- Understanding self and Personal Branding, attitude, types of attitude, Positive Attitude, Self Confidence and Self-Motivation - Personal Application/Action Taken. Advanced Writing Skills-Principles of Business Writing- E mails- Writing Reports- Types of Reports- Strategies for Report Writing- Personal Application/Action Taken. Verbal Ability- Analogy- Classification- Odd One Out-

Idioms and Phrases- Sentence Correction- Empathy and its importance in career -Personal Application/Action Taken.

Module 2: Interpersonal Communication **10 Hours**

Nonverbal Communication- Individual, Groups and Cultures- Body Language- Attire and Etiquettes- Interpersonal Skills- dealing with diverse People- Networking- Emotional Intelligence and its importance. Personal Application/Action Taken. Developing Creativity- Critical Thinking and Problem Solving Skills- Making the Right Choice- Never Give Up- Begin to Grow- Personal Application/Action Taken. Interviews- Facing Job Interviews - Planning and Preparing- Effective Resume along with Covering Letter- Planning and Preparing- Personal Application/Action Taken. Self-Discipline - Self Presentation - Personal Application/Action Taken.

Module 3: Teamwork and Leadership Skills **10 Hours**

Industry Expectations- Universal Hiring Rule- Personal Application/Action Taken. Importance of Human Values-Importance of Team Work- Developing Key Traits in Motivation, Persuasion, Negotiation and Leadership Skills- Being an Effective Team Player- Personal Application/Action Taken. Planning- Prioritization - Delegation- Conflict Management- Decision and its necessity in crucial situations- Group Discussion- Personal Application/Action Taken. Essential Skills in working Strategies- Presentation and Interaction Skills- What to Present and How- Being Assertive- Multimedia Presentation-Making Effective Presentations. Interview Skills- Do's and Don'ts - Body Language – Answering the Common Questions of Interview- Performance Evaluation 2- Mock Interview

Total Hours:	**30**

Text Books:

1.	Penrose, "Business Communication for managers: An advanced approach", Cengage learning.
2.	H.E. Sales, "Professional Communication in Engineering", Palgrave Macmillan 2009.
3.	W. P. Scott, Bertil Billing, "Communication for Professional Engineers", Thomas Telford, 1998.

Reference Books:

1.	Peter Davson-Galle, "Reason and Professional Ethics", Ashgate Publishing, Ltd., 2009.

3.	Joep Cornelissen, “Corporate Communications: Theory and Practice”, Sage Publications India Pvt Ltd, New Delhi, 2004.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc16_hs15/preview
2	https://www.getinternship.switchidea.com/NTAT/syllabus/Interpersonal-Communication.
3	https://smude.edu.in/smude/programs/bca/soft-skills.html
Online Resources:	
1	https://swayam.gov.in/course/4047-developing-soft-skills-and-personality
2	https://www.clearias.com/interpersonal-skills-including-communication-skills-for-csat/
3	https://www.bizlibrary.com/soft-skills-training/

Assessment Methods & Levels (based on Revised Bloom’s Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:40)			
Course Outcome	**Revised Bloom’s Level**	**Assessment Component**	**Marks**
C103.1	Remember	Group Discussion	10
C103.2 & C103.3	Understand	Listening Skills	10
C103.4	Apply	Interview	10
C103.5 & C103.6	Apply	Formal Presentation	10

Revised Bloom’s Level	**Tentative End Assessment Examination (Theory) [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C103.1						1	1	2	2	3	2	2			1
C103.2							1	1	3	3	2	2			1
C103.3									2	3	2	2			1
C103.4						1	1	1	2	3	3	2			1
C103.5						1	1		2	3	2	2			1
C103.6							1	2	3	3	2	2			1

20MC105	GENERAL APTITUDE	2/0/0/0
Nature of Course	Problem analytical	
Pre requisites	Basic Mathematical calculations	

Course Objectives:

1	To ensure that students learn to think critically about mathematical models for relationships between different quantities and use those models effectively to solve problems and reach conclusions about them.
2	To impart skills that enable students to effectively use and interpret data, formulas, and graphs in the workplace.
3	To instills confidence in facing technical aptitude questions interviewed by recruiters.

Course Outcomes:

Upon completion of the course, students shall have ability to

C105.1	To teach the basics of Quantitative Techniques in a graded manner.	[R]
C105.2	Understand the verbal and non-verbal nature of problems in reality and know the shortcut methods of solving it.	[U]
C105.3	Solve problems using their general mental ability.	[AP]
C105.4	To give intense focus on improving and increasing the ability of solving real problems.	[AP]
C105.5	Think critically about mathematical models for relating different quantities to reach conclusion.	[AP]
C105.6	Enable effective use of data interpretation, formulas, graphs and assumptions.	[AP]

Module 1: Number Theory and Statistics **14 Hours**

Number Systems– HCF and LCM of Numbers – Decimal Fractions – Simplification – Square Root and Cube Root of a number – Surds and Indices – Problems on numbers – Percentage – Ratio and Proportion – Divisibility – Mixtures – Averages- Polynomials – Solving Equations and Inequalities – Discard's rule of signs – Problems on ages – Chain rule – Time and Work – Time and Distance – Problems on Trains – Problems on Boats and Streams- Measures of central tendency – Mean, Median and Mode – Variance and Standard deviation Logarithms – Profit and Loss – Simple Interest – Compound Interest.

Module 2: Logic and Decision Making **8 Hours**Analogy – Classification – Series completion – Coding and Decoding – Blood Relations – Puzzle Test – Direction Sense test – Logical Venn Diagrams - Number Ranking and Time

Sequence Test – Decision Making – Assertion and Reason– Inserting the missing one – Logical Sequence of words – Syllogisms.

Module 3: Reasoning **8 Hours**

Logic – Statement and Arguments – Statements and Assumptions – Statements and Course of Action – Statements and Conclusions – Deriving conclusions from passages – Functions – Different kinds of functions – Miscellaneous sets- Series – Analogy – Classifications – Analytical Reasoning – Problems on Cubes and Dice – Mirror Images – Water Images – Rule Detection.

Total Hours:	**30**

Text Books:

1	Aggarwal R. S, "Quantitative Aptitude" Revised Edition, S. Chand Publication.
2	Abhijit Guha, "Quantitative Aptitude" 5th Edition, McGraw Hill Education.

Reference Books:

1	Edgar Thorpe "Mental Ability & Quantitative Aptitude" 3rd Edition, McGraw Hill Education.

Web References:

1	https://www.wiziq.com/tutorial/815468-quantitative-aptitude-reasoning-data-interpretation-video-lectures
2	https://learningpundits.com/contest?referrer=harsh.cse15@nituk.ac.in
3	https://nptel.ac.in/courses/114106041/8
4	https://nptel.ac.in/courses/111103020/2

Online Resources:

1	http://aptitudetraining.in/home/index.php
2	https://www.udemy.com/vedicmaths/
3	https://www.youtube.com/channel/UCtmn-DsF4BhPug-ff9LiDAA?disable_polymer=true

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Revised Bloom's Level	Assessment Component	Marks
C105.1	Remember	Classroom or Online Quiz	10
C105.2 & C105.3	Understand	Formal presentation	10

C105.4, C105.5 & C105.6	Apply	Formal interview tests	20
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Term End Assessment Examination (Theory) [60 marks]**		
Remember	20		
Understand	40		
Apply	40		
Analyse	-		
Evaluate	-		
Create	-		

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C105.1	3	3	1												
C105.2	3	2	1												
C105.3	3	3	1												
C105.4	3	2	1										2		
C105.5	3	3	1										2		
C105.6	3	2	1										2		

20MC106	LIFE SKILLS AND ETHICS	2/0/0/0
Nature of Course	Theory Concept	
Pre requisites	Nil	

Course Objectives:

1	To develop communication competence in prospective engineers.
2	To enable them to convey thoughts and ideas with clarity and focus.
3	To develop report writing skills.
4	To equip them to face interview & Group Discussion.
5	To inculcate critical thinking process.
6	To prepare them on problem solving skills.
7	To provide symbolic, verbal, and graphical interpretations of statements in a problem description.

Course Outcomes:

Upon completion of the course, students shall have ability to

C106.1	Define and identify different life skills required in personal and professional life.	[U]
C106.2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.	[AP]
C106.3	Explain the basic mechanics of effective communication and demonstrate these through presentations.	[AN]
C106.4	Use appropriate thinking and problem-solving techniques to solve new problems.	[AP]
C106.5	Understand the basics of teamwork and leadership	[U]

Course Contents:

Communication Skill:

Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

Critical Thinking & Problem Solving:

Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats Mind Mapping & Analytical Thinking. Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Ethics, Moral & Professional Values:

Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE. **Leadership Skills:** Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation

Total Hours:	**30**

Reference Books:

1	Barun K. Mitra, "Personality Development & Soft Skills", First Edition, Oxford Publishers, 2011.
2	Kalyana, "Soft Skill for Managers", 1st Edition, Wiley Publishing Ltd, 2015.
3	Larry James, "The First Book of Life Skills", 1st Edition, Embassy Books, 2016
5	John C. Maxwell, "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc, 2014.

Web References:

1	https://www.coursera.org/courses?query=ethics

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Bloom's Level	Assessment Component	Marks
C106.1	Remember	Quiz	**5**
C106.2	Understand	Assignment	**15**
C106.3	Understand	Presentation	**10**
C106.4 C106.5	Apply	Group Discussion	**10**

Summative assessment based on Continuous Assessment

Revised Bloom's Level	Term End Assessment [60 marks]
Remember	30
Understand	40
Apply	30
Analyse	-

Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C106.1								1	2	1		2	1		
C106.2								1	2	1		2	1		
C106.3								2	2	3		1	1		
C106.4								1	1	1		1	3		
C106.5								1	3	2		2	1		

20MC107	STRESS MANAGEMENT	2/0/0/0
Nature of Course	Theory Concept	
Pre requisites	Nil	

Course Objectives:

1	Understand the basic principles of stress management
2	Recognize your stress triggers and how to manage them
3	Develop proactive responses to stressful situations
4	Use coping tips for managing stress both on and off the job
5	Learn to manage stress through diet, sleep and other lifestyle factors
6	Develop a long term action plan to minimize and better manage stress
7	Understand the basic principles of stress management

Course Outcomes:

Upon completion of the course, students shall have ability to

C107.1	Understand the basic principles of stress management	[U]
C107.2	Apply the concept of recognizing your stress triggers and find was to manage them.	[AP]
C107.3	Develop proactive responses to stressful situations	[AN]
C107.4	Develop a long term action plan to minimize and better manage stress	[AP]

Course Contents:

Scientific Foundations of Stress:

What is stress? – Sources of Stress – Types of Stress – Personality Factors and stress – Stress and the college student. Stress Psychophysiology: Stress and nervous system – Hypothalamic – Pituitary – Adrenal (HPA) Axis – Effect of Stress on Immune system – Health risk associated with chronic stress – Stress and Major Psychiatric disorders.

Developing Resilience to Stress:

Understanding you stress level – Role of personality pattern, Self-esteem, Locus of control – Role of Thoughts Beliefs and Emotions – I & II – Life situation Intrapersonal: (Assertiveness, Time Management).

Strategies for Relieving Stress:

Developing cognitive coping skills – Autogenic training, imagery and progressive relaxation – Other relaxation techniques – Exercise and Health – DIY strategies stress management.

Total Hours:	**30**

Reference Books:	
1	Jonathan C. Smith, “Stress Management: A Comprehensive Handbook of Techniques and Strategies”, 1st Edition, Springer Publishing Company, 2011.
2	Bob Stahl, Elisha Goldstein, Jon Kabat-Zinn, “A Mindfulness–based Stress Reduction Workbook”, 2nd Edition, New Harbinger Publications, 2019.
3	Ryan M. Niemiec, “The Strengths-based Workbook for Stress Relief”, 1st Edition, New Harbinger Publications, 2019.
Web References:	
1	https://thiswayup.org.au/courses/coping-with-stress-course/
2	https://www.classcentral.com/course/swayam-stress-management-14309

Assessment Methods & Levels (based on Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C107.1	Remember	Quiz	**10**
C107.2	Understand	Group Discussion	**10**
C107.3	Understand	Class Presentation	**10**
C107.4	Apply	Assignment	**10**

Summative assessment based on Continuous Assessment	
Revised Bloom’s Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C107.1								1	3			1	1		

C107.2								1	2	1		1	1		
C107.3								1	3	1		2	2		
C107.4								1	3	1		3	2		

20MC108	CONSTITUTION OF INDIA	2/0/0/0

Nature of Course : Theory

Pre Requisites : Nil

Course Objectives:

1	To familiarize with basic information about Indian constitution
2	To understand the fundamental rights and duties as citizens of India

Course Outcomes:

Upon completion of the course, students shall have ability to

C108.1	Explain the objectives of the Constitution of India and its formation	[U]
C108.2	Recall state and central policies (Union and State Executive), fundamental Rights and their duties.	[R]
C108.3	Make use of legal directions in developing solutions to societal issues	[AP]
C108.4	Utilized for competitive exams that requires knowledge of Indian Constitution	[AP]

Course Contents:

Module 1 **10 Hours**

Historical perspective, The making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Citizenship Article 5-11.

Module 2 **10 Hours**

Federal structure, Powers of the Union and the states, Centre-State Relations, Union Executive – President, Prime Minister, Union Cabinet, Parliament, Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Elections, Electoral Process, and Election Commission of India, Election Laws. Powers and Functions of Municipalities and Panchayat

Module 3 **10 Hours**

Amendments - Methods, Emergency Provisions, National Emergency, President Rule, Financial Emergency, Provisions for SC & ST, OBC, women, children and backward classes, Right to Property, Freedom of Trade and Commerce. Agricultural Law

Total Hours: 30

Text Books:

1	Dr. D. D. Basu, “Introduction to the Constitution of India”, LexisNexis, New Delhi, 22nd Edition, 2016.
2	“Bare act-constitution of India”, The universal Publications, LexisNexis 2020, New Delhi, India.

Reference Books:	
1	Subhash. C. Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust, India, 5th Edition, 2019.
2	M. Laxmikanth, “Constitution of India”, Cengage Learning India, 1st Edition 2018.
Web References:	
1	https://unacademy.com/course/the-indian-constitution/NSKQ8XXQ
2	https://unacademy.com/goal/upsc-civil-services-examination-ias-preparation/KSCGY

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C108.1	Remember	Test	10
C108.4	Understand	Quiz	10
C108.3	Apply	Presentation	10
C108.2	Apply	Group Assignment	10

Summative assessment based on Continuous Assessment	
Revised Bloom’s Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C108.1						3	1	1	1			1	1	1	
C108.2						3	1	1	1			1	1	2	
C108.3						3	2	2	1			1	1	2	
C108.4						3	1	1	1			2	1	1	

20MC109	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2/0/0/0
Nature of Course : Theory		
Pre Requisites : Nil		

Course Objectives:

1	To make understand the contribution of Indian mind in various fields.
2	To cultivate critical appreciation of the thought content and provide insights relevant for promoting cognitive ability, health, good governance, aesthetic appreciation and right values.

Course Outcomes:

Upon completion of the course, students shall have ability to

C109.1	Relate classical Indian traditions with contemporary traditions and culture.	[R]
C109.2	Outline the thoughts of Indians in different disciplines.	[U]
C109.3	Apply the knowledge to the present context.	[AP]
C109.4	Develop a better appreciation and understanding of Indian traditions.	[C]

Course Contents:

Indian Ethics: Individual and Social – Society state and Polity (Survey) - Education systems – Agriculture (Survey) – Early & Classical Architecture – Medieval & Colonial Architecture.

Astronomy in India – Martial Arts Traditions (Survey) - Indian Literatures - Indian Philosophical Systems - Indian Traditional Knowledge on Environmental Conservation

Ayurveda for Life, Health and Well-being - The Historical Evolution of Medical Tradition in Ancient India- Music in India - Classical & Folk

Total hours:	**30**

Text Books:

1	Kapil Kapoor and Michel Danino, “Knowledge Traditions and Practices of India”, Central Board of Secondary Education, 2017.
2	Yogesh Atal, “Indian Society: Continuity and Change”, Pearson Education India, 2016.

Reference Books:	
1	Douglas Osto, “An Indian Tantric Tradition and Its Modern Global Revival”, Routledge publications, 2020.
2	Rao C.N. Shankar, “Sociology: Principles of Sociology with an Introduction to Social Thoughts”, S Chand Publisher, 2019.
Web References:	
1	http://nopr.niscair.res.in/handle/123456789/43
2	https://nptel.ac.in/courses/109/104/109104102/

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:100)			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C109.1	Remember	Quiz	10
C109.2	Understand	Group Assignment	10
C109.3	Apply	Presentation	10
C109.4	Create	Survey	10

Summative assessment based on Continuous Assessment	
Revised Bloom’s Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C109.1						2	1	1	1			2	3	1	
C109.2						2	1	1	2			1	2	1	
C109.3						1	1	1	1			1	1	1	
C109.4						2	1	1	2			2	1	1	