Integrated M Sc. Data Science

(Exit option with B.Sc Data Science & B.Sc (Honors) Data Science)

CURRICULUM AND SYLLABUS

(From 2026 Admission Onwards)

Integrated M. Sc. Data Science

Program Outcomes

PO1 Knowledge in Mathematics and Computer Science: Understand the basic concepts, fundamental principles and the scientific theories related to Data Science.

PO2 Abstract thinking: Ability to absorb and understand the abstract concepts that lead to various advanced theories in Mathematics, Statistics and Computer science.

PO3 Modelling and solving: Ability in modelling and solving problems by identifying and employing the appropriate existing theories and methods.

PO4 Advanced theories and methods: Understand advanced theories and methods to design solutions for complex data science problems.

PO5 Applications in Engineering and Sciences: Understand the role of mathematical sciences and apply the same to solve the real life problems in fields of data science.

PO6 Modern software tool usage: Acquire the skills in handling scientific tools towards problem solving and solution analysis.

PO7 Environment and sustainability: Understand the significance of preserving the environment towards sustainable development.

PO8 Ethics: Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality. Continue to enhance the knowledge and skills in mathematics and computer science for constructive activities, and demonstrate highest standards of professional ethics.

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: Develop various communication skills such as reading, listening, and speaking which will help in expressing ideas and views clearly and effectively.

PO11 Project management and Research: Demonstrate knowledge, understand the scientific and management principles and apply these to one's own work, as a member/ leader in a team to manage projects and multidisciplinary research environments. Also use the research-based knowledge to analyse and solve advanced problems in data science.

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.

Five Year Integrated M Sc – Data Science

(Exit option with B.Sc Data Science & B.Sc (Honors) Data Science)

(2026 admission onwards)

Course Code	Course Title	L T P	Cr	Course Code	Course Title	L T P	Cr
	SEMESTER 1				**SEMESTER 2**		
24ENG101	English I	2 0 0	2	24ENG111	English II	1 0 2	2
	Language Paper I	2 0 0	2		Language Paper II	2 0 0	2
26MAT103	Single Variable Calculus	3 1 0	4	26MAT111	Multivariable Calculus	3 1 0	4
26MAT104	Discrete Mathematics	3 0 2	4	26MAT112	Linear Algebra	3 0 2	4
26PHY101	Introduction to Data Science	3 0 2	4	26CSC111	Advanced Computer Programming	3 0 0	3
26CSC101	Problem Solving and Computer Programming	3 0 0	3	26CSC112	Digital Electronics	3 0 0	3
26CSC181	Problem solving computer Lab.	0 0 2	1	26CSC182	Advanced Computer Programming Lab.	0 0 2	1
22ADM101	Foundations of Indian Heritage	2 0 1	2	26CSC183	Digital Electronics Lab	0 0 2	1
				22ADM111	Glimpses of Glorious India	2 0 1	2
				22AVP103	Mastery Over Mind	1 0 2	2
	TOTAL		**22**		TOTAL		**24**
	SEMESTER 3				**SEMESTER 4**		
26CSC201	Data Structures	3 1 0	4	26MAT211	Statistical Inference Theory	3 0 0	3
26MAT202	Optimization Techniques	3 1 0	4	26MAT212	Convex Optimization	3 0 0	3
26MAT203	Probability Theory	3 1 0	4	26CSC211	Machine Learning	3 0 0	3
26MAT204	Numerical Methods	3 1 0	4	26CSC212	Design and Analysis of Algorithms	3 0 2	4
26CSC202	Database Management Systems	3 0 2	4	26CSC213	Data Visualization	3 0 2	4
23ENV300	Environmental Science		P/F		Open Elective A*	3 0 0	3
	Amrita Values Programme I	1 0 0	1	26CSC282	Machine Learning	0 0 2	1
26CSC281	Data Structures lab	0 0 2	1	23LSK211	Life Skills II	1 0 2	2
26CUL200	Integrated Amrita Meditation Technique	0 0 2	1		Amrita Values Programme II	1 0 0	1
23LSK201	Life Skills I	1 0 2	2				
	TOTAL		**25**		TOTAL		**24**
	SEMESTER 5				**SEMESTER 6**		
26CSC301	Operating Systems	3 0 2	4	26MAT311	Graph Analytics and Algorithms	3 0 2	4
26MAT301	Multivariate Statistics for Data Science	3 0 2	4	26MAT312	Regression Analysis	3 0 2	4
26CSC302	Number Theory and Information Security	3 1 0	4	26CSC311	Artificial Intelligent	2 0 2	3
26CSC303	Theory of Computation	3 1 0	4	26CSC312	Software Engineering	3 0 2	4

26CSC304	Deep Learning	3 0 0	3	26CSC313	Computer Networks	3 0 2	4
26MAT390	Live-in-Lab.@ / Open Elective B*	3 0 0	3	26MAT313	Data Governance, Ethics and Law	1 0 0	1
23LSK301	Life Skills III	1 0 2	2	26CSC382	Open Lab I: C Programming	1 0 2	2
26CSC381	Deep Learning-Lab	0 0 2	1		TOTAL		**22**
				26CSC399	Project for Exit option students		05
	TOTAL		**25**		TOTAL for exit option students		**27**
				Exit option with B.Sc Data Science			**147 credits**
	SEMESTER 7				**SEMESTER 8**		
26CSC401	Large Language Models	3 0 2	4	26CSC411	Internet of Things	2 0 2	3
26CSC402	Deep Learning for Natural Language Processing	3 0 2	4	26CSC412	Quantum computing	3 0 2	4
26CSC403	Reinforcement Learning	3 0 2	4		Elective III	3 0 0	3
26CSC404	Data Security	3 0 0	3		Elective IV	3 0 0	3
	Elective I	3 0 0	3		Elective V	3 0 0	3
	Elective II	3 0 0	3	26CSC499	Mini Project		5
26CSC481	Open Lab-II-JAVA Programming	1 0 2	1	26CSC482	Open Lab III (**Apache Spark / Big ML** /Apache Hive/..)	0 0 2	1
	TOTAL		**22**		TOTAL		**22**
				Exit option with B.Sc (Honors) in Data Science			**191 credits**
	SEMESTER 9				**SEMESTER 10**		
26CSC598	Project –I (Internship in Industries / Universities)		8	26CSC599	Project-II (Research based) Dissertation		12
	Elective VI	3 0 0	3				
	Elective VII	3 0 0	3				
	Total		**14**		TOTAL		**12**
					Total Credits	**212**	

ELECTIVES

	MATHEMATICS STREAM				**COMPUTER SCIENCE STREAM**		
26MAT331	Real Analysis	2 0 2	3	26CSC331	Soft Computing	2 0 2	3
26MAT332	Advanced Algebra	2 0 2	3	26CSC332	Cryptography	2 0 2	3
26MAT333	Transform Techniques	2 0 2	3	26CSC333	Business Analytics	2 0 2	3
26MAT334	Advanced Big Data Analytics	2 0 2	3	26CSC334	Deep Learning for Image Processing	2 0 2	3
26MAT335	Differential Equations	2 0 2	3	26CSC335	Predictive Analytics	2 0 2	3
26MAT336	Random Process for Data Science	2 0 2	3	26CSC336	Mining of Massive Datasets	2 0 2	3
26MAT337	Time Series Analysis	2 0 2	3	26CSC337	Data Compression	2 0 2	3
26MAT338	Wavelets	2 0 2	3	26CSC338	Introduction to Embedded Systems	2 0 2	3
26MAT339	Computational Geometry	2 0 2	3	26CSC339	Information retrieval	2 0 2	3

26MAT340	Queuing Theory and Inventory Control Theory	2 0 2	3	26CSC340	Social Network Analytics	2 0 2	3
26MAT341	Theory of Sampling and Design of Experiments for Data Analysis	2 0 2	3	26CSC341	Big Data Storage and Analysis	2 0 2	3
26MAT342	Data Analytics in Computational Biology and Drug Designing	2 0 2	3	26CSC342	Full Stack Development	2 0 2	3
26MAT343	Statistical Quality Control	2 0 2	3	26CSC343	Cloud Computing	2 0 2	3
26MAT344	Six Sigma Analytics	2 0 2	3	26CSC344	Data Wrangling	2 0 2	3
26MAT345	Statistical Pattern Recognition	2 0 2	3	26CSC345	Parallel and Distributed Systems	2 0 2	3
				26CSC346	High Performance Computing	2 0 2	3
				26CSC347	Practical Techniques for Big Data	2 0 2	3
				26CSC348	Agentic AI	2 0 2	3
				26CSC349	Probabilistic Graphical Models	2 0 2	3
				26CSC350	Quantum Machine Learning	2 0 2	3

Elective courses can be taken from online courses, industry electives and other B.Tech / M.Tech/ M. Sc programmes.

	Paper I						**Paper II**			
24MAL101	Malayalam I	2 0 0	2	B		24MAL111	Malayalam II	2 0 0	2	B
24HIN101	Hindi I	2 0 0	2	B		24HIN111	Hindi II	2 0 0	2	B
24KAN101	Kannada I	2 0 0	2	B		24KAN111	Kannada II	2 0 0	2	B
24SAN101	Sankrit I	2 0 0	2	B		24SAN111	Sanskrit II	2 0 0	2	B
24TAM101	Tamil I	2 0 0	2	B		24TAM111	Tamil II	2 0 0	2	B
24ENG100	Additional English – I	2 0 0	2			24ENG110	Additional English - II	2 0 0	2	

Table 3 New names for Amrita Value Programmes I & II for UG programmes			
Course Code	**Title**	**L-T-P**	**Credits**
22ADM201	Strategic Lessons from Mahabharata	1-0-0	1
22ADM211	Leadership from Ramayana	1-0-0	1
22AVP210	Kerala Mural Art and Painting	1-0-0	1
22AVP218	Yoga Therapy and Lessons	1-0-0	1
22AVP212	Introduction to Traditional Indian Systems of Medicine	1-0-0	1
22AVP201	Amma's Life and Message to the modern world	1-0-0	1
22AVP204	Lessons from the Upanishads	1-0-0	1
22AVP205	Message of the Bhagavad Gita	1-0-0	1
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
22AVP208	Insights into Indian Arts and Literature	1-0-0	1
22AVP213	Traditional Fine Arts of India	1-0-0	1
22AVP214	Principles of Worship in India	1-0-0	1
22AVP215	Temple Mural Arts in Kerala	1-0-0	1
22AVP218	Insights into Indian Classical Music	1-0-0	1
22AVP219	Insights into Traditional Indian Painting	1-0-0	1
22AVP220	Insights into Indian Classical Dance	1-0-0	1
22AVP221	Indian Martial Arts and Self Defence	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

Evaluation Pattern:

S.No	Course Type	Theory / Lab	Mid Term marks	CA marks	End Semester marks
1	Theory / Theory with Lab courses	Theory	30	30	40
3	Lab courses (0- 0- 2- 1)	Lab	-	60	40

SEMESTER 1

24ENG101 **English I** **2 0 0 2**

Objectives:

To help students obtain an ability to communicate fluently in English; to enable and enhance the students' skills in listening, speaking, reading, and writing; to impart an aesthetic sense and enhance creativity

Cos	Course Outcomes
CO1	Demonstrate competence in the mechanics of writing
CO2	Summarise audio and written texts to convey messages effectively
CO3	Apply mechanics of writing and AI tools to draft academic and professional documents
CO4	Organise ideas and thoughts for clear written and oral communication
CO5	Critically evaluate literary texts

Unit I: Mechanics of writing-Parts of speech use of prepositions, adjectives, adverbs and determiners– word order–collocation – concord (Subject-Verb, Pronoun-Antecedent) – kinds and patterns of sentences

Unit II: Tenses - Modal auxiliaries - Reported speech - Active and Passive Voice - Phrasal Verbs - Linkers/ Discourse Markers- Question Tags

Unit III: Pre-writing techniques - Paragraph writing – Cohesion – Development – types: definition, comparison, classification, contrast, cause and effect - Essay writing: Descriptive and Narrative - Introduction to the use of Gen AI in writing (AI tools, Do's and Don'ts while using AI, how to write prompts, etc.)

Unit IV: Listening comprehension (3 pieces – Do Schools kill creativity? By Sir Ken Robinson, Steve Jobs' 2005 Stanford Commencement Address, India Questions Dr Abdul Kalam-Aired August 2007) – Reading Comprehension – Skimming and Scanning-Inference and Deduction –Reading different kinds of material– Speaking**:** Narration of incidents/ stories/ anecdotes.

Unit V: Shashi Tharoor–"'Kindly Adjust to Our English" A.G.Gardiner–"A Fellow Traveller" Ruskin Bond – "The Eyes Have It" Mrinal Pande – "Girls" W.H.Auden–"Unknown Citizen" W H Davies - "Leisure"

References:

1. Murphy, Raymond, *Murphy's EnglishGrammar,*CUP,2004
2. Syamala,V.*SpeakEnglishinFourEasySteps*,Improve English FoundationTrivandrum:2006
3. Martinet, Thomson, *A Practical English Grammar*, IVEd.OUP,1986.
4. TheWeek-June03,2018,LASTWORD;https://www.theweek.in/columns/shashi-tharoor/2018/05/25/kindly-adjust-to-ourenglish.html?fbclid=IwAR3IhtdXqvuV4ySECn9S7SA6HmCEYISyd1QHd3BlwKgiNKKwd

keSg3qWp-U/
5. AGGardiner–*LeavesintheWind*,Digicat(e-book),2015
6. RuskinBond–*TheBestofRuskinBond*;IndiaPenguin.April 2016.
7. MrinalPande–*SteppingOut*;PenguinIndia;2003
8. WHAuden–*AnotherTime*;RandomHousePub;1940
9. WilliamHDavies–*SongsofJoyandOthers*;AndesitePress,August2017.
10. SirKenRobinson–"Doschoolskillcreativity?".https://go.ted.com/6WoC
11. Steve Jobs' 2005 Stanford Commencement Address. https://youtu.be/UF8uR6Z6KLc?si=1nMNYJOk3Yw7H7tF
12. India Questions Dr Abdul Kalam (aired: August 2007). https://youtu.be/erg3CmVm6M4?si=YudsxXZOFY1do91C

24MAL101 **Malayalam I** **2 0 0 2**

Course Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in arrange of contexts and for a variety of purposes
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course Outcomes	
CO1	Develop the ability to read and critically appreciate a given text
CO2	Develop fluency in speaking the language
CO3	Ability to blend language and Indian spirituality.

Unit	**Topic**
1	**Adhyatmaramayanam,** Tharopadesam(Enthinnu Sokam….thulom) **Jnanappana**(sthanamanangal.…Trishnakondubhramikkunnathokkeyum)
2	Modern Poets:Mampazham-Vyloppilly Sreedharamenon Criticalanalysis of the poem.
3	Short stories from period1/2/3:**Poovanpazham**-Vaikaom Muhammed Basheer
4	LiteraryCriticism:**Bharatha Paryatanam**-*Vyasante Chiri*–Ithihasa studies-Kuttikrishna Marar-Outline of literary Criticism in Malayalam Literature
5	Error-free Malayalam: **1**. Language; **2**. Clarity of expression;

	3. Punctuation-Thettillatha Malayalam–Writing- **a**. Expansion of ideas; **b**. Precise Writing; **c**. EssayWriting

Textbooks/Reference:

1. Adhyatmaramayanam–ThunjathRamanujanEzhuthachan
2. Ramayanavichinthanam-Dr.A.M.Unnikrishnan
3. ThunjanPadhanangal-Prof.PanmanaRamachandran
4. CompleateWorksincludingJnanappana-Poonthanam
5. Vyloppilly-M.N.Vijayan
6. Vyloppilli-Vyakthi,Kavi-Dr.M.Leelavathi/S.GupthanNair
7. BasheerintePoonkavanam-Prof.M.N.Karasseri
8. Basheer-Life&Works
9. BharathaParyatanam-KuttikrishnaMarar
10. LavanyasastrathinteYukthisilpam-Dr.ThomasMathew
11. ThettillathaMalayalam–Prof.PanmanaRamachandranNair(Hisall booksonErrorFree Malayalam)

24HIN101 **HINDI I** **2 0 0 2**

Course Objective: The course will enable the students to understand the basics of grammar and usage, to appreciate the literary compositions, and to understand the intricacies of language and literature.

Course Outcomes	
CO1	Distinguish various literary genres.
CO2	Explore tradition and culture through literature.
CO3	Apply the basics of grammar.
CO4	Critically analyse the prescribed literary texts.

Unit 1: Hindi Sahithya ki Panch shresht Kahaniyam**:**

a) Sughmay Jeevan–Chandradhar Sharma,Guleri

b) Dhan ki Bhent-Rabindranath Tagore

c) Anbola–Jayashankar Prasad

d) Swamini(Manasrovarbhagh-1)Premchand

Unit II: Hindi Kavitha:

a) 'Aarya"–Maithili Sharan Gupth

b) "MeribhiabhaheIsmein'.,"Mubarak Ho Naya Saal"-_Nagarjun

c) "Nishaa Kirodeta Rakesh-Niharse'.,Shoonya Mandirmein Banoongi-Sandhya Geet se- Mahadevi varma

d) ’Khoob Ladi Mardanivahtho Jhansi Valiranithi’-subhadra Kumarichohan

Unit III: Hindi Ekanki**:**

a) Mohan Rakesh:Andeke Chilke

b) Vishnu Prabhakar:Sarkari Noukari

Unit IV: Grammar:

1) Karak
2) Upasarg
3) Pratyay
4) Vakya Rachana
5) Padaparichay.
6) Sarvanam
7) kriya
8) Adjective
9) Adverb
10) Tenses

REFERENCE

1) SugamHindiVyakarn,:Prof.Vanshidhar&DharmapalShastri
2) VyavaharikHindiVyakarantathaRachana:Dr.HardevBahari Shiksharthi HindiVyakaran:Dr. Nagappa
3) HindiSahithyakiPanchshreshtKahaniyam:Editedby:Dr.SachidanandhShuklu (Printed and Published by V&S publishers, Abridged, AnsariGanj, Delhi)
4) HindiSamay.com,/Hindikahani.com/exoticindiaart.com

24KAN101 Kannada I 2 0 0 2

Objectives:

- To enable the students to acquire basic skills in functional language.
- To develop independent reading skills and reading for appreciating literary works.
- Enable students to communicate in the language they have studied in arrange of contexts and for a variety of purposes
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

Course Outcome

CO1	Develop the ability to read, listen and write in Kannada and to understand and use the language in a variety of contexts and situations
CO2	Enable the learners to understand the grammatical structures of classes of words
CO3	Develop ability to speak fluently and interactively in both personal and professional context

Unit – 1: Adalithadalli Kannadadabalake : (Use of Kannada in business and administration) Bhashe – swaroopa, stityantaragalu, Aadubhashe, pradeshikabhashe, Grantikabhashe Paaribhaashika padagalu
Unit – 2 : Padagalarachane, deshiya–anyadeshiyapadagalu Lekhana Chinnhegalu Kannada bharavanigeya shuddhamattua shuddharoopagalu, Dwiruktigalu, jodunudigalu
Unit – 3: Nudigattgalu, gaadevistarane Listening to radio speech, tongue twister- practice
Unit – 4: Patra Lekahna-aupachaari kahaaguanoupa chaarika Kandike galarachane Prabandhagalu:vivaranaatmaka haaguniroopanatmaka
Unit – 5: Poems

a) Vachanagalu–kaalugalembavugaalikandaya Allamaprabhu,Ratnadasankoleyaadadetodarallve– Akkamahadevi, ole hatti uridare nilabahudallade - Basavanna
b) Keerthanegalu–Tanuvanirolagaddiphalavenu– Purandaradasa, Tallanisadirukandya taalumanave-Kanakadaasa
c) Tripadigalu–Saalavanukombaagahaalogarundante-Sarvagna
d) Janapadageetegalu-Yaakebadtaadtitamma
e) Shortstories
f) Sambhanda–ShrikrishnaAlanahalli
g) Moksha– Sethuram

Prabandhagalu

1. Namma Maneya Deepa–Ha.Ma.Nayak
2. Bhadhuku Kanasalla, Ondhu Kale–NKKulakarni

References:

1. H.S.KrishnaswamyIyangaar–AdalithaKannada–Chetanapublication,Mysuru
2. KannadaVyakaranamattuRachane–N.GopalakrishnaUdupa,M.C.C.Publication
3. G.H.Naayak –Kannada Sanna Kathegalu–Chetana Book House
4. ShatamaanadaLalithaPrabandha–GurulingaKaapase-KarnatakaSahityaAcademy
5. Naavalla–Kathasankalana–Sethuram
6. Basavannanavara Vachanagalu – G.V.Shastri – Paaruprakashana
7. KannadadaBalake– H.S.Krishnaswamy Iyangaar – Chetanabookhouse
8. SarvagnanaVachanagalu – VenkataSubbaiha,Vijayavaahini Publications.

24SAN101 SANSKRIT I 2 0 0 2

Course Objectives:

- To enable the students to acquire basic skills in functional language
- To develop independent reading skills and reading for appreciating literary works.
- To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech
- Grasp the connection between Sanskrit language and Indian philosophy

Course Outcomes:

CO1 : Read and understand Sanskrit verses and sentences and communicate in Sanskrit
CO2 : Imbibe values of life and Indian tradition propounded by the scriptures

Module I: Introduction to Sanskrit language, Devanagari script - Vowels and consonants, pronunciation, classification of consonants, conjunct consonants, words – nouns and verbs, cases – introduction, numbers, Pronouns, communicating time in Sanskrit. Practical classes in spoken Sanskrit
Module II : Verbs-Singular, Dual and plural—First person, Second person, Third person. Tenses–Past, Present and future–Atmanepadiandparasmaipadi-kartharipraYoga.
Module III : General group words for communication and moral stories.
Module IV : Chanakya Neeti chapterIII(partI), Bhagavad Gita chapter14(part I)
Module V: Translation of simple sentences from Sanskrit to English and vice versa.

24TAM101 TAMIL I 2 0 0 2

Course Objectives:

To teach Tamil for effective communication in different spheres of life:-cultural relations in society.

Course Outcomes:

1. Giving exposure to history of Tamil literature and Introduction of select Classics
2. Initiating Students to the spirit of Bhakti literature
3. Encouraging creativity of students by teaching Contemporary Literature poetry, modern poetry, Short Story, Prose, Novel, etc
4. Introduction of basic Grammar, Letter writing and essay writing skills of Tamil language.

$ல g-1

தdழ்இலக்gயவரலாற்□ல்சங்கஇலக்gயம்: □தல், gைஇட, gைகடசங்கம். சங்கஇலக்gயங்கள்பத்Fப்பாட்□.

g□ந்ெதாைக(6,8பாடல்கள்),

yறநா□□(184,192பாடல்கள்).

சங்கம்ம□aயகாலஇலக்gயம்:

□லப்பொகாரம்(வழக்gைறக்காைத),

பொெணண்வழ்கணக்g□ல்கள்,

ொ□க்gறள்(ம□ந்F)

UNIT-1 HistoryofTamil Literature: First, Intermediate, Last sangam. Sangam Literature, Pattuppaattu. Kuṟuntogai, Puṟanaanuuru.

Literature of the Sangam Maruviya period – Silappathiagaram (vazhakkuraikaathai), PatiṇeṇkiizhKaṇakkuNuulkal. TirukkuṟaL(Marunthu)

$லg2

பக்ொஇலக்ழயம்:–

பன்னி□ொ□□ைறகள்அ□□கம்,
மாணிக்கவாசகர்(ொ□வாசகம்-□வyராணம்)

UNIT2BhaktiLiterature–IntroductiontoPanniruThirumuraikal,Manikkavasagar(Thiruvasagam-SivaPuranam)

$லg-3

தற்காலஇலக்ழயம்:-

கaைத:பொயார்(g□ல்பாட்□),பாரொதாசன்(தdpன்இனிைம).

உைரநைட: ஞா.ேதவேநயப்பாவாணர்(தdாம்ொரaட□ம்சமமா?),

பரிொமாற்கைலஞர்(தdழ்ெமாp□ன்வரலா□(ஆாவரலா□)).

□ற்m(வள்சுவர்வgக்gம்இன்பம்)

□□**கைத**: அழழயெபரியவன் –(வனம்மாள்)

நாவல்: ைஇமயம்(ெபத்தவன்)

Unit- III ContemporaryLiterature:Poetry-Bharathiar(kuyilpāṭṭu),Bharathidasan(tamiḻiṉiṉimai,iṉpattamiḻ) Pattukottai Kalyanasundaram.

Prose:G.DevaneyaBhavanar(TamizhumDhiravidamumsamamaa?),Paritimāṟkalaiñar(paranarkettaparisu),chirbi (valluvarvakukkuminbam)

ShortStory:AzhagiyaPperiyavan–
(VanammaaL) Novel: Imaiyam (Peththavan)

$லg–4ெதால்காப்mயம்:
எாத்F – mறப்mயல்.
நி□த்தக்g□கள்மற்□ம்

கJதம்எாFதநம்கட்□ைரஎாFதநம்

UNIT–4tolkāppiyam:Alphabet–piṟappiyal.PunctuationmarksandLetterwritingandessaywriting.

REFERENCE

ைஇமயம்,ெபத்தவன்,க்ரியாெவளிP□2019.

அழழயெபரியவன்,அழழயெபரியவன்கைதகள்,நற்□ைணபொப்பகம்,2016

□.பாலBப்mரமணியன்,கட்□ைர-வளம்,ந□மலர்ப்பொப்பகம்,பத்தாம்பொப்y1994
பரிொமாற்கைலஞர்,தdழ்ெமாp□ன்வரலா□,$ம்yகார்பொப்பகம்,
ஆறாம்பொப்y2013. அகளங்கன்,பன்னி□ெொ□□ைற–
அ□□கம்,இந்Fமாமன்றம்வஹனியா,1994

ரா.□னிவாசன,தdழ்இலக்ழயவரலா□,https://ta.wikisource.org/s/99uk

மாணிக்கவாசகர்(ெொ□வாசகம்-□வyராணம்

ெபான்மணிமாறன்“அேடான்தdழ்இலக்கணம்“அேடான்பப்ளிூங்g□ப்,வஞ்□$ர்,

ெொ□வனந்தyரம், 2007. http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.html

26MAT103 Single Variable Calculus 3 1 0 4

Course Description: This course introduces the fundamentals of calculus through hands-on learning using any mathematical software. Topics include various concepts from differential calculus and integral calculus. Lab exercises provide graphical understanding about the topics.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Improving the skills of visual understanding of the graph of the function and the concepts of limit, continuity and differentiability.
CO2. Understanding the basic concepts of Derivative of a function.
CO3. Applying the knowledge of derivative of a function to identify extreme values and concavity.
CO4. Understanding the concept of integration and apply the same to evaluate the area between curves.
CO5. Applying the concept of differentiation and integration in application related problems in science and engineering.

Unit 1 LIMITS AND CONTINUITY

Shifting and Scaling of Graphs – Rates of Change and Limits – Limits of Function Values – Calculating Limits Using the Limit Laws – Continuity – Tangents and Derivatives. (Chapter 1- Sec: 1.5, Chapter 2-Sec: 2.1, 2.2, 2.6 and 2.7)

Unit 2 DIFFERENTIATION

The Derivative as a Function – Differentiation Rules – The Derivative as a Rate of Change – Derivatives of Trigonometric Functions – The Chain Rule and Parametric Equations – Implicit Differentiation – Linearization and Differentials. (Chapter 3- Sec: 3.1 to 3.6, 3.7, Self-Study - Sec: 3.7)

Unit 3 APPLICATION OF DERIVATIVES

Extreme values of Functions – The Mean Value Theorem – Monotonic Functions and the First Derivative Test – Concavity and Curve Sketching – Anti Derivatives. (Chapter 4- Sec: 4.1 to 4.4 and 4.8)

Unit 4 THE DEFINITE INTEGRAL

Estimating with Finite Sums –Sigma Notation and Limits of Finite Sums–The Definite Integral– The Fundamental Theorem of Calculus – Indefinite Integrals and the Substitution Rule – Substitution and Area between Curves. Basic Integration Formulas – Integration by Parts – Integration of Rational

Functions by Partial Fractions – Trigonometric Integrals – Trigonometric Substitutions – Improper Integrals. (Chapter 5- Sec: 5.1 to 5.6, 8.1 to 8.5, 8.8)

Unit 5 APPLICATIONS OF DEFINITE INTEGRALS

Volumes by Slicing and Rotation About an Axis – Solids of Revolution: The Disk Method– Solids of Revolution: The Washer Method–Volumes by Cylindrical Shells–The Shell Method–Slope Fields and Separable Differential Equations –First-Order Linear Differential Equations. (Chapter 6- Sec: 6.1 to 6.2, Chapter 9- Sec: 9.1 to 9.2).

To understand the basic concepts of Mathematical reasoning, set and functions.
To understand various counting techniques and principle of inclusion and exclusions.
Understand the concepts of various types of relations, partial ordering and equivalence relations.
Apply the concepts of generating functions to solve the recurrence relations.

Text Books:

1. Finney and Thomas, "Calculus", Pearson, Eleventh Edition, 2008.

References

1. Howard Anton, IRl Bivens, Stephens Davis, "Calculus" Wiley, 10th Edition, 2016 Reprint.
2. M. J. Strauss, G. L. Bradley and K. J. Smith, "Calculus", 3rd Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2007.
3. James Stewart, "Calculus: Early Transcendentals", Cengage (India), 8th Edition, 2016.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	3							1
CO2	2	3	3	3	3							1
CO3	2	3	3	3	3							1
CO4	2	3	3	3	3							1
CO5	2	3	3	3	3							1

26MAT104 Discrete Mathematics

3 0 2 4

Course Outcomes:

CO1: To understand the basic concepts of Mathematical reasoning, set and functions.
CO2: To understand various counting techniques and principle of inclusion and exclusions.
CO3: Understand the concepts of various types of relations, partial ordering and equivalence relations.
CO4: Apply the concepts of generating functions to solve the recurrence relations.

CO5: Familiarise the fundamental concepts of graph theory and shortest path algorithm.

Phase I

Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving, Functions, Mathematical Induction. Recursive Definitions, Recursive

Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations. (Sections: 1.1 - 1.4, 1.6 -1.8, 2.3, 5.1 - 5.4, 6.1 - 6.3 and 5.5)

Phase II

Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions. (Sections: 9.1, 9.3 - 9.6)

Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion. (Sections: 8.1 - 8.6)

Phase III

Graph Theory: Introduction to Graphs, Graph Operations, Graph and Matrices, Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest Path Problem, Planar Graph, Graph Colorings and Chromatic Polynomials. (Sections: 10.1 - 10.8).

Course Outcomes:

TEXT BOOKS:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Eighth Edition, 2019.

REFERENCES:

1. R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
2. Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.
3. Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited, 200

CO-PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	1						1
CO2	2	2		1	3							1
CO3	3	3		1	2	1						1
CO4	3	1	3	1	2							1
CO5	3	2	3	3	3	2						1

26PHY101 Introduction to Data Science 3-0-2-4

Unit-1

Introduction, Toolboxes: Python, fundamental libraries for data Scientists. Integrated development environment (IDE). Data operations: Reading, selecting, filtering, manipulating, sorting, grouping, rearranging, ranking, and plotting.

Unit-2

Introduction, Causality and Experiments, Data Preprocessing: Data cleaning, Data reduction, Data transformation, Data discretization. Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of exploratory data analysis, Randomness, Probability, Introduction to Statistics, Sampling, Sample Means and Sample Sizes.

Unit-3

Data Acquisition, Data Entry, Signal Reception, Data Extraction. Data Warehousing, Data Cleansing, Data Staging, Data Processing, Data Architecture. Data Mining, Clustering/Classification, Data Modeling, Data Summarization. Exploratory/Confirmatory, Predictive Analysis.

Unit 4

Descriptive statistics – Central tendency, dispersion, variance, covariance, kurtosis, five point summary, Distributions, Bayes Theorem, Error Probabilities; Permutation Testing, Statistical Inference; Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, A/B Testing, P-Values, Causality.

Unit-5

Estimation, Prediction, Confidence Intervals, Inference for Regression, Classification , Graphical Models, Updating Predictions.

TEXT BOOKS

1. Adi Adhikari and John DeNero, "Computational and Inferential Thinking: The Foundations of Data Science", e-book.

REFERENCES:

1. Data Mining for Business Analytics: Concepts, Techniques and Applications in R, by Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr., Wiley India, 2018.
2. Rachel Schutt & Cathy O'Neil, "Doing Data Science" O' Reilly, First Edition, 2013.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								2
CO2	3	3	2	2								2
CO 3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3								2

26CSC101 Problem Solving and Computer Programming 3 0 0 3

Course Description: This course provides a comprehensive introduction to programming using Python, covering essential syntax, data types, variables, control flow, and functions. Designed for beginners, it emphasizes hands-on coding through exercises, often using IDLE or Jupyter Notebooks, to teach problem-solving, and script development.

Course Outcomes: After successful completion of the course, students will be able to
CO1: Understand Python basics and learn to write algorithms
CO2: Understand the logic and able to write control and looping statements
CO3: Work on sequence and non-sequence types
CO4: Create functions and modules and able to handle the errors and exceptions
CO5: Able to store, retrieve, and manipulate data in text files

Unit 1: Algorithms, Flowcharts, Variables, Data Types, Type Casting, Assignment, Keywords, Input-Output, Indentation, Operators and Expressions: Types - Integers, Strings, Booleans, Operators: Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and Order of Precedence.

Unit 2: Control Flow, Selection: if, if-else, Multi-way Selection and Nested Structures. Repetition: While Loops and Counters, For Loops, Nested Loops, Ranges.

Unit 3: Sequence Types: List Operations, Tuples, Slicing, Concatenation and Repetition Operators, Non-Sequence Types: Set, Frozen Set, Mapping Types: Dictionary, Comprehensions, Text Sequence Type: String Operations.

Unit 4: Functions: Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions, Scope of the Variables in a Function - Global and Local Variables, Module Creation, Import Statements, Name Spacing, Exception handling.

Unit 5: Text Files: Text Files and Their Format, Writing Text to a File, Writing Numbers to a File, Reading Text from a File, Reading Numbers from a File, Accessing and Manipulating Files on Disk. Regular Expressions: Character Matching in Regular Expressions, Extracting Data using Regular Expression.

Text Books:

1. Guttag, John. Introduction to Computation and Programming Using Python: With Application to Understanding Data Second Edition. MIT Press, 2016. ISBN: 9780262529624.

References:

1. VanderPlas, J. (2023). Python data science handbook: Essential tools for working with data

(2nd ed.). O'Reilly Media, Inc.

2. Vamsi Kurama (2017), Python Programming: A Modern Approach, Pearson.

CO-PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2	2					2	
CO2	2	2	3		2	2					2	
CO3	3	2	3		2	2					2	
CO4	3	2	3		2	2					2	
CO5	3	2	2		2	2					2	

26CSC181 Problem Solving Computer Programming Lab
0 0 2 1

Course Description: This lab course introduces the fundamentals of the Python language through hands-on practice, enabling students to write, debug, and execute python programs for various applications.

Course Outcomes: After successful completion of the course, students will be able

CO1. Understand the evaluation of expressions in python
CO2. Understand the logic and able to write control and looping statements
CO3. Work on sequence types, non-sequence types and text files
CO4. Create functions and modules
CO5. To handle the errors and exceptions

1. Installing Python environments
2. Using Python Interpreter to do basic operations like arithmetic computations.
3. Working with variables of different datatypes and using them in expressions.
4. Implementing logic requiring conditional expressions and looping
5. Working with strings using inbuilt functionalities of the datatype
6. Working with Python inbuilt datatypes like Lists, Tuples and Dictionaries
7. Working with modularity: Implementing functions and designing logic in a modular fashion
8. Creating programs by importing user defined modules
9. Implement unit testing measures, assertions and exception handling
10. Creating programs to handle text files

Text Book:

1 Guttag, John. Introduction to Computation and Programming Using Python: With Application to Understanding Data Second Edition. MIT Press, 2016. ISBN: 9780262529624.

CO-PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3		2	2					2	

CO2	2	2	3		2	2					2	
CO3	3	2	3		2	2					2	
CO4	3	2	3		2	2					2	
CO5	3	2	2		2	2					2	

SEMESTER 2

24ENG111 **English II** **1 0 2 2**

Objectives:

To train students to convey and document information in a formal environment; to facilitate them to acquire the skill of self-projection in professional circles; to inculcate critical and analytical thinking.

Cos	Course Outcomes
CO1	Illustrate comprehension of the fundamentals of writing
CO2	Analyse audio text focusing on English phonetics, pronunciation and meaning comprehension
CO3	Apply theoretical knowledge to write professional documents
CO4	Infer from current news to formulate ideas and opinions
CO5	Prepare appropriate content for mini project and make effective presentation

Unit I : Vocabulary Building: One-word substitutes; Antonyms and Synonyms; Words often Confused Error Analysis (Subject-Verb Agreement; Tense Sequence; Usage of Articles and Prepositions; Determiners; Redundancy); Modifiers (misplaced**,** dangling, etc.)

Unit II: Circulars; Memos; Formal Letter writing; e-Mail Etiquette; Instruction, Suggestion & Recommendation; Essay writing: Analytical and Argumentative

Unit III : Sounds of English: Stress, Intonation - Listening Comprehension (3 pieces – Women in Technology Panel discussion, India Questions Abdul Kalam, UPSC Topper Mock interview Akshat Jain)-Current News Awareness

Unit IV: Reports: Incident Report, Event Report Situational Dialogue; Group Discussion(Opinion)

Unit V: Mini Project and Presentation

References:

1. FelixaEskey.*TechTalk*, University of Michigan.2005
2. MichaelSwan.*PracticalEnglishUsage*,OxfordUniversityPress.2005
3. Anderson, Paul. *Technical Communication: A Reader Centered Approach*, V Edition, Hercourt, 2003 .
4. Martinet,Thomson, *A Practical English Grammar*,IVEd.OUP, 1986.
5. RaymondV.LesikarandMarieE.Flatley.*BasicBusinessCommunication*,Tat a McGraw Hill Pub. Co. New Delhi. 2005. Tenth Edition.
6. Thampi,G.Balamohan.*MeetingtheWorld:WritingsonContemporaryIssues*.Pearson,2013.
7. Lynch,Tony.*StudyListening*.NewDelhi:CUP,2008.
8. Kenneth,Anderson,TonyLynch,JoanMacLean.*StudySpeaking*.NewDelhi:CUP,2008.
9. Marks,Jonathan.*EnglishPronunciationinUse*.NewDelhi:CUP,2007.

10. Syamala, V. *Effective English Communication for You (Functional Grammar, Oral and Written Communication)*: Emerald, 2002.
11. SampleQuestionPapersfromCompetitiveExaminations
12. Women in Technology Panel discussion
    https://youtu.be/T44XdGH5s-8?si=A1cDVEt777FH7vFR
13. India Questions Abdul Kalam

https://youtu.be/erg3CmVm6M4?si=WjP_SV1vy6FrsGHg
14. UPSC Topper Mock interview, Akshat Jain
    https://youtu.be/lsJBGvyiAHI?si=L-u6kTadzJmghHLI

24MAL111 **Malayalam II** **2 0 0 2**

Course objective:

- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language
- To enable the students to plan, draft, edit & present a piece of writing.

Course outcomes:

CO1:Develop the ability to read and critically appreciate a given text
CO2:Develop fluency in communication
CO3:Develop interest in blending of language and Indian Spirituality
CO4:To enable the learners to understand the grammatical structures of classes of words

Unit Topic

1 Memoirs-One of the Selecrtion from Chiudambara Smarana-Balachandran Chullikkadu-Critical analysis of his poetry)
2 Ancient Drama: Kerala Sakunthalam(Act 4), Kalidasan(Transilated by Attoor Krishna Pisharody).
3 Satire One of the Selection from Chemmanam Chacko, VKNOr Punathil Kunjabdulla-philosophical dimens of Satire
4 Part of anauto-biography/travelogue:
Valarnnuvarunnaoratmavu(from Kanneerum Kinavum)-VT Bhattathirippad
5 Error-free Malayalam:
1.Language;
2.Clarity of expression;
3.Punctuation-Thettillatha Malayalam – Writing-
a. Expansion of ideas

Text books/Reference:

1) Hasa Sahithyam Kutti Krishna Mararu
2) Sakunthalam - Attoor/Kutti krishna Marar
3) Kalidasa Hridayam-K.P.Narayana Pisharady
4) VKN-K.P.Appan

5) N.V.Krishna Warriar &Modern Poetry studies
6) Kanneerum Kinavum–V.T.Bhattathirippad
7) Adukkalayil Ninnu Arangatheykku-V.T.Bhattathirippadu
8) Nalla Malayalam-C.V.Vasudeva Bhattathiri
9) Tettum Sariyum-Prof.Panmana Ramachandran Nair

24HIN111 HINDI II 2 0 0 2

Course Objective: The course will allow students to apply grammar in language structures, appreciatetheliterarycompositionsandprovidethemwithagoodcommandover translation techniques.

Course outcomes: By the end of the course the students will be able to:

1. Understand the post modern trends of literature.
2. Explore tradition and culture through literature.
3. Apply ethical and professional translation strategies.
4. Demonstrate linguistic competence in written communication.

Unit1

Hindi Laghu Upanyas**: MamathaKaliya-'Doud'**

Unit 2

Hindi Natak**:**Swadesh Deepak-"KortMarshal"

Unit3

Adhunik Hindi Kavya

a. Jayashankar Prasad-(Lahar, Aah! Vedhana Mili Vidayi).,

b.Suryakanth Tripathi „Nirala"- (Anamika -4).,

c.Subadhra Kumari , Chouhan- (Swadesh Ke Prathi, Smruthiyam),

d.Gajanan Madhav Muktibodh- (ek swapna Katha)

Unit4

A) Sankshepan,

B) Anuvad: Paribhasha, Prakar, Anuvad Ke Lakshan, Anuvad Ki Avashyakata, Passage (Translation)

C) Paragraph writing

D) Technical writing

REFERENCE

1. Prayojan Mulak Hindi Ke Naye Ayam: Dr.Pandit Banne
2. Prayojan Mulak Hindi Ki Nayi Bhumika :Kailash Nath Pandey
3. Prayojan Mulak Hindi Ke Vividh Roop :Dr.Rajendra Mishra, Rakesh Sharma
4. "Adhunik Kavya Sangraha" Edited by Dr. Urvashi Sharma(Printed and Published by Malik & Company, Jaipur)
5. Hindi Samay.com,/Hindikahani.com/exoticindiaart.com

24KAN111 **Kannada II** **2 0 0 2**

Objectives:

- To develop the standard of orthography and spelling system.
- To develop independent reading skills and reading for appreciating literary works.
- To develop elaboration and modernization of the vocabulary of a language.
- To enable the students to plan, draft, edit & present a piece of writing.

Course Outcome

CO1	Develop the ability to read and critically appreciate a given text
CO2	Develop pattern of communication as required for different professional context
CO3	Develop fluency in speaking the language

CourseContents

UNIT–1

Prabandhagalu

- Thotadacheya Bhoota–Kuvempu
- Bantu Bannada Holi–G.S.Shivarudrappa

UNIT–2

Poems

- Nihinganodabayda Nanna–Da.Ra.Bendre
- Huttarihaadu–Panje Mangesh Rao
- Tungabadre–K.S.Narasimhaswamy
- Nanna Janagalu–Dr.Siddhalingaya

UNIT–3

Novel

- Jugari Cross–PoornachandraTejaswi

UNIT–4

- Suttole
- Kadata
- Prakatane
- Arjigalu
- Aadeshapatraa

UNIT-5

- Varadigalu
- Sanshikpta Baravanige

• Prabandhagalu: vaadaatmakahaaguvishleshanatmaka

References:

1. Jugari Cross–Poornachandra Tejaswi–Pustaka Prakashana
2. Shatamaanada Lalitha Prabandha–Gurulinga Kaapase-Karnataka Sahitya Academy
3. N.GopalkrishnaAdiga–KannadaVyakaranamattuRachane–MCCPublications
4. Maadhari Patragalu–S.R.Siddharaju–Kannada Saahitya Parishattu
5. H.S.Krishnaswamy Iyangar–Adalitha Kannada–Chetana publication,Mysuru

24SAN111 SANSKRIT II 2 0 0 2

Module I : Seven cases, Avyayas, sentence making with Avyayas, Sapthakakaras.
Module II: Kthavathu Prathyaya, Upasargas, Kthvatha, Thumunnantha, Lyabantha Prathyaya. Three Lakaras– brief introduction, Lot lakara
Module III : New words and sentences for the communication, Slokas, moral stories, Subhashithas, riddles (Selected from the Pravesha Book)
Module IV : Introduction to classical literature, classification of Kavyas, classification of Dramas-Important five Mahakavyas

Module V : Translation of paragraphs from Sanskrit to English and vice versa
Module VI: Chanakya Neeti chapterIII(PartII), Bhagavad Geeta chapter14(PartII)

Essential Reading:

1, Praveshaha;Publisher:Samskritabharati,Aksharam,8thcross,2ndphase,girinagar, Bangalore -560 085
2, Sanskrit ReaderI, II and III, R.S.Vadhyarand Sons, Kalpathi, Palakkad
3, PrakriyaBhashyam written and published by Fr. John Kunnappally
4, Sanskrit Primer by Edward Delavan Perry, published by Ginnand Company Boston 5, Sabdamanjari, R.S. Vadyar and Sons, Kalpathi, Palakkad
6, NamalinganusasanambyAmarasimhapublishedbyTravancoreSanskritseries
7, SubhashitaRatnaBhandakarabyKashinathSharma,publishedbyNirnayasagarpress

24TAM111 TAMIL II 2 0 0 2

Course Objective: The course will allow students to understand the writing competency in Tamil literature.

Course outcomes: By the end of the course the students will be able to:

1. Introduction to Tamil Folklore
2. Learning the nuances of Tamil spiritual literature
3. Exposure to the advanced aspects of Tamil grammar
4. Imbibing the spirit of language through familiarising with linguistics, translation and

creative writing

அலg1

□ற்□லக்ழயங்கள்அ□□கம்:கaங்கத்Fப்பரணி(பேபார்ேபாJயF),
□கூடற்பள்சு35.ேநாட்□yறaயல்:வரரaலக்கணம்,
ேநாட்□yறப்ேபாடல்கள், கரதகள், கரதப்ேபாடல்கள், பழமேமாp,
a□கரதகள், கரலகள்.

IntroductiontoCiRRilakkiyam:Kalingaththupparani(PoorPadiyathu)-MukkdaRpallu35.Folklore: Definition, Folksongs - Stories – kathaipPaadal - pazhamozhi - vidukathai - kalaikaL.

அலg2

பக்ொஇலக்ழயம்:ஆண்ேடாள்□ாவரேலா□,ெ□ப்ேபாரவ(1,2,3,4)

அலg3

மேதால்ேகாப்mயம்: மேபா□ளிலக்கணம் - ேமால்aலக்கணம்

அலg 4

மேமாpமபயப்y:மேமாpமபயப்yவரகக்ள,மேமாpமபயர்ப்mன்□க்ழயF வ□ம்பதரவyம்,இயந்ொரமேமாpமபயர்ப்y,மேகாள்ரகக்ள,இலக்ழயமே மாpமபயர்ப்y.மேமாp□யல்அ□□கம்:மேமாpyம்மேமாp□யஙம், பயன்ேபா□மேமாp□ன்தன்ரமகள் ,மேமாp□யல்Fரறகள்.பரடப்yஉ□ேவாக்gதல்(க□த்Fபரிமாற்றம்-கaரதஇலக்ழயம்-அ□□கம்,a□தரலக்g□ன்Fம்mன்Fம்-நாடகம்-□□கதத).

Translation:Typesoftranslation- Importanceandneedoftranslation- Machinetranslation- Principles - Literary translation.

Introduction to Linguistics: Language and Linguistics- Linguistics – Characteristics of applied language– FieldsofLinguistics. Creationofcreativity(Exchangeofideas- introductionto poetry literature, before and after liberation - drama - short story).

REFERENCES

□.வரதேரான்“தdழ்இலக்ழயவரேலா□”
ே○○ா□த்யஅகமடdபப்ளிபகஷன்ஸ்,2012 மேபான்மணிேமாறன்
“அபேடான்தdழ்இலக்கணம்“அபேடான்பப்ளிரூங்g□ப்,வஞ்□$ர்,
ெ□வனந்தyரம்,2007.http:/www.tamilvu.org/libirary/libindex.htm.
http:/www.gunathamizh.com/2013/07/blog0post_24.htmlேநா.ேவானேமாமரல,
“தdழர்ேநாட்□ப்ேபாடல்கள்” நி$மஞ்Bரிyத்தகமவளிPட்டகம் 1964,2006
ேநா.ேவானேமாமரல“பழங்கரதகசும்,பழமேமாpகசும்

”நி$மஞ்Bரிyத்தகமவளிPட்டகம்,1980,2008

26MAT111	Multivariable Calculus	3 1 0 4

Course Description: This course introduces the fundamentals of multivariable calculus through hands-on learning using MATLAB. Topics include differential, integral and vector calculus for functions of more than one variable. These mathematical concepts are used extensively in engineering, physical sciences and in the machine learning optimization algorithms.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Understand and apply concepts of vector-valued functions, space curves, curvature and motion in space. Apply partial derivatives for tangent planes and Hessian matrix.
CO2. Analyze scalar and vector fields using gradient, divergence, curl and Laplacian.
CO3. Evaluate double integrals and surface integrals using Jacobian transformations.
CO4. Apply Green’s, Stokes’ and Gauss divergence theorems in solving physical and mathematical problems.

Unit 1: Vector Function and Space Curve: Vector-valued functions of a real variable - Algebraic operations, limits, derivatives and integrals. Parametric representation of space curve, tangent, principal normal and arc length of a space curve. Applications to curvilinear motion: velocity, speed and acceleration. TB2 - Vol.1, Chapter 14: Section 14.1 to 14.10.

Partial Derivatives: Functions of several variables, limits and continuity, partial derivatives, higher order partial derivatives, Tangent planes and linear approximations, maximum and minimum values, Hessian matrix and its interpretation.

TB3 – 14.1, 14.2, 14.3, 14.6, 14.7

Unit 2 : Differential calculus of scalar and vector fields: Scalar point function and vector point function, scalar and vector fields. Examples: Euclidean distance field, velocity field, gravitational field and force field. Gradient of scalar field and its geometrical interpretation, level sets, gradient as surface normal, directional derivatives, conservative fields and potential functions. Divergence and Curl of vector field, physical interpretation, Laplacian of scalar field, vector identities involving gradient, divergence and curl.

TB1 - 9.4, 9.7, 9.8, 9.9

Unit 3 : Double Integrals and Surface Integrals: Geometrical interpretation of double integrals, evaluation of double integrals change of order of integration, Jacobian and change of variables in double integrals. Parametric representation of surfaces, the fundamental vector product as a normal to the surface, surface and flux integrals with physical applications.

TB1 - 10.3, 10.5, 10.6

Unit 4 : Fundamental Theorem on Vector Calculus: Line integrals, path independence of line integrals, Green's theorem in the plane, Stokes theorem and Gauss Divergence theorem with geometrical and physical interpretations and applications.

TB1 - 10.1, 10.2, 10.4, 10.7, 10.9

Suggested lab exercises:
Plot the vector valued function and visualize the space curve.
Find the velocity and acceleration vector for the parametric curve and plot them.

1. Plotting the scalar field and vector field.
2. Draw the level curves and level surfaces.
3. Find the gradient of the function and represent the gradient vector field graphically.
4. Find the Jacobian matrix and Jacobian determinant of the given transformation.
5. Find the divergence, curl and Laplacian of the given function.
6. Test whether the vector field is conservative or not.
7. Plot the surface of the function and visualize using 3D surface plot and contour plot.
8. Plot the function and observe the peaks and valleys.

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley and Sons, Tenth Edition, 2011.
2. Tom M. Apostol, Calculus, Volume 1, John Wiley & Sons, Second edition, 2007.
3. George B. Thomas and Maurice D. Weir, *Thomas' Calculus*, 14th Edition, Pearson Education, 2018.

CO-PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	2							
CO2	2	2	2	2	1							
CO3	1	1	2	2	1							
CO4	1	3	1	3	3							
CO5	1	2	2	2	2							

26MAT112 Linear Algebra 3 0 2 4

Course Outcomes:

CO1. Solve systems of linear equations using matrix operations and row reduction methods.
CO2. Understand vector spaces, subspaces, basis, dimension, and rank–nullity concepts.
CO3. Apply inner product and orthogonality concepts including projections and least squares methods.
CO4. Understand and apply concepts of vector-valued functions, space curves, curvature and motion in space. Apply partial derivatives for tangent planes and Hessian matrix.
CO5. Compute eigenvalues and eigenvectors and perform diagonalization and matrix decompositions.

CO-PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	1	2	1	2							
CO2	2	2	1	2	1							
CO3	2	1	2	2	1							
CO4	2	2	1	2	2							
CO5	2	1	2	1	2							

Syllabus:

Systems of Linear Equations and Matrices: Vectors; Matrices; Systems of Linear Equations; Echelon form; Row reduction; Gaussian elimination method.

Vector Spaces: Vector spaces; Sub spaces; Linear dependence and independence; Basis and Dimension; Fundamental Matrix Spaces; Rank-Nullity Theorem.

Inner Product Spaces: Inner products; Orthogonality; Orthogonal basis; Orthogonal complements; Projection on subspace; Gram Schmidt Process; QR Decomposition; Least Square Principle; Least Square Fitting to Data.

Linear Transformations: Linear transformation; Relation between matrices and linear transformations; Kernel and range of a linear transformation; Rank-Nullity Theorem, Change of basis; Orthogonal transformations and rotations; Nilpotent transformations, Unitary, Hermitian, and skew Hermitian matrices or operators; Self-Adjoint and Normal operators.

Eigen values and Eigen vectors: Eigenvalues and Eigenvectors; Diagonalization; Orthogonal Diagonalization; Quadratic Forms; Similarity of linear transformations; Diagonalisation and its applications - Jordan canonical form. *LU*-Decomposition, Singular Value Decomposition.

Lab Experiments:

1. Matrix operations, Finding determinant, rank, inverse, Generation of random matrices with given rank
2. Solving systems of linear equations using Gaussian elimination
3. Transforming a set of vectors into an orthonormal basis.
4. Factoring a matrix into lower and upper triangular matrices.
5. Factoring a matrix into an orthogonal matrix and an upper triangular matrix.
6. Compute eigenvalues/eigenvectors of matrices and visualize their geometric meaning.
7. Compute large matrix powers by diagonalizing a matrix
8. Computing SVD for dimension reduction and data analysis.
9. Least Square Fitting to Data.
10. Scaling, Shifting, Rotation of imagesusing Linear Transformations

Text Book:

1 Howard Anton and Chris Rorres, “Elementary Linear Algebra”, Tenth Edition, John Wiley & Sons, 2010.

References:

1. Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.
2. Sheldon Axler, Linear Algebra Done Right, Springer, 2014.
3. Gilbert Strang, “Linear Algebra for Learning Data”, Cambridge press, 2019.

26CSC112 Digital Electronics 3 0 0 3

Course Outcomes;

CO1. Understand the basics of digital electronics.
CO2. Understand and apply the concepts of sequential and combinational circuits to different problems.
CO3. Understand functionalities of various memory devises.
CO4. Analysis of Synchronous Sequential Circuits Asynchronous Sequential Circuits.

MINIMIZATION TECHNIQUES AND LOGIC GATES:

Minimization Techniques: Boolean postulates and laws – De-Morgan‟s Theorem - Principle of Duality - Boolean expression - Minimization of Boolean expressions — Minterm – Maxterm - Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization – Don‟t care conditions – Quine - Mc Cluskey method of minimization. Logic Gates: AND, OR, NOT, NAND, NOR, Exclusive–OR and Exclusive–NOR Implementations of Logic Functions using gates, NAND–NOR implementations – Multi level gate implementations- Multi output gate implementations. TTL and CMOS Logic and their characteristics – Tristate gates

COMBINATIONAL CIRCUITS:
Design procedure – Half adder – Full Adder – Half subtractor – Full subtractor – Parallel binary adder,parallel binary Subtractor – Fast Adder - Carry Look Ahead adder – Serial Adder/Subtractor - BCD adder – Binary Multiplier – Binary Divider - Multiplexer/ Demultiplexer – decoder - encoder – parity checker – parity generators – code converters - Magnitude Comparator.

SEQUENTIAL CIRCUITS:
Latches, Flip-flops - SR, JK, D, T, and Master-Slave – Characteristic table and equation –Application table – Edge triggering – Level Triggering – Realization of one flip flop using other flip flops – serial adder/subtractor- Asynchronous Ripple or serial counter – Asynchronous Up/Down counter - Synchronous counters – Synchronous Up/Down counters – Programmable counters – Design of Synchronous counters: state diagram- State table –State minimization –State assignment - Excitation table and maps-Circuit implementation - Modulo–n counter, Registers – shift registers - Universal shift registers – Shift register counters – Ring counter – Shift counters - Sequence generators.

MEMORY DEVICES:
Classification of memories – ROM - ROM organization - PROM – EPROM – EEPROM – EAPROM,RAM – RAM organization – Write operation – Read operation – Memory cycle - Timing wave forms – Memory decoding – memory expansion – Static RAM Cell- Bipolar RAM cell – MOSFET RAM cell – Dynamic RAM cell –Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using ROM, PLA, PAL

SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS:
Synchronous Sequential Circuits: General Model – Classification – Design – Use of Algorithmic State Machine – Analysis of Synchronous Sequential Circuits Asynchronous Sequential Circuits: Design of fundamental mode and pulse mode circuits – Incompletely specified State Machines – Problems in Asynchronous Circuits – Design of Hazard Free Switching circuits. Design of Combinational and Sequential circuits using VERILOG.

TEXT BOOK:
1. M. Morris Mano, "Digital Design", 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.

REFERENCES:
1. R. H. Katz and G. Boriello, Contemporary Logic Design, 2nd Ed., Prentice Hall of India, 2009.John F.Wakerly, "Digital Design", Fourth Edition, Pearson/PHI, 2008.
2. A. P. Malvino, D. P. Leach and G. Saha, Digital Principles and Applications, 7th Ed., McGraw Hill, 2010.
3. John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.

CO–PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2			2						1
CO2	3	2	2			2						2
CO3	3	2	3	2		2						2
CO4	2	2	3	2		2						1

26CSC111 Advanced Computer Programming 3 0 0 3

Course Objectives:
To equip students with advanced Python programming skills by integrating object-oriented design, package development, data preprocessing and visualization, web scraping, database connectivity, and GUI application development for solving real-world computational problems.

Course Outcomes:

CO5. Apply object-oriented programming principles to design and implementation.
CO6. Utilize predefined Python packages and develop user-defined packagesfor computational tasks.
CO7. Perform data preprocessing operations and visualize data effectively using Matplotlib and Seaborn.
CO8. Extract and process web data using BeautifulSoup, and apply regular expressions for pattern matching.
CO9. Develop Python applications that integrate MySQL database operations and design graphical user interfaces using Tkinter widgets.

CO–PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2			1			2	2		
CO2	3	2	2		1	3						2
CO3	3	2	3	2	2	3				1		
CO4	2	2	3	2		3				2		
CO5	2		3	1	1	3			2	3	2	

Unit I: Object Oriented Programming: abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, overloading.

Unit II: Packages: importing predefined packages, using random, math, statistics, time, and calendar. User defined packages: Creating and structuring packages, importing, __init__. Exercises to understand usage of Numpy, SciPy, Pandas.

Unit III: Data Preprocessing: Data integration, cleaning, reduction, transformation, normalization and discretization**. Data Visualization:** Matplotlib: figures, subplots, markings, color and line styles, labels and legends, Line, bar, Scatter plots, histograms, stacked bars, pie chart, 3D Plotting. Sea born: Relational Plots, Categorical Plots, Distribution Plots, Regression Plots, Heat map.

Unit IV: Web scraping: Introduction, request module, Beautiful soup package, parsing: title, head, body, h1, p, link. Tag object, contents, children, attributes. Functions: find, find all. **Regular expression:** regex, search, match, find all, characters and special sequences, extracting mail id and web address from webpages.

Unit V: DBMS: Connection to MySQL database, Create and Drop table, Insert, Update, Delete, and Select. **GUI:** Introduction to Tkinter, working with different widgets: Entry Widget, Text Widget, Radio Button, Check Button, List Boxes, Menus, and Combo Box, Button.

TEXT BOOK:

1. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, O'Reilly Media, 2024.
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, Second edition (27 October 2017), Shroff/O'Reilly, ISBN-10: 9789352136414, ISBN-13: 978-9352136414.

REFERENCES:

1. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
2. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010
3. Adi Adhikari and JohnDeNero, "Computational and Inferential Thinking: The Foundations of Data Science", e-book.

26CSC182 Advanced Computer Programming Lab 0 0 2 1

Course Outcomes:

CO1. Apply object-oriented programming principles to design and implementation.
CO2. Utilize predefined Python packages and develop user-defined packagesfor computational tasks.
CO3. Perform data preprocessing operations and visualize data effectively using Matplotlib and Seaborn.
CO4. Extract and process web data using BeautifulSoup, and apply regular expressions for pattern matching.
CO5. Develop Python applications that integrate MySQL database operations and design graphical user interfaces using Tkinter widgets.

CO–PO Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2			1			2	2		
CO2	3	2	2		1	3						2
CO3	3	2	3	2	2	3				1		
CO4	2	2	3	2		3				2		
CO5	2		3	1	1	3			2	3	2	

List of Exercises:

1. Develop programs using classes, objects, and methods.
2. Apply inheritance and encapsulation concepts in program design.
3. Implement polymorphism techniques, including method overloading.
4. Install external packages and utilize them in Python scripts.
5. Create programs to import and use user-defined packages.
6. Apply NumPy and SciPy to solve basic mathematical problems.
7. Implement data handling operations in Pandas for working with CSV data.
8. Read noisy datasets and perform data preprocessing using Pandas.
9. Implement various plotting and charting techniques using Matplotlib.
10. Analyze datasets and identify suitable features for visualization using Seaborn.
11. Develop Python scripts to retrieve and process web data, including parsing, searching, and formatting, using Beautiful Soup, urllib, and Regular Expressions.
12. Implement database access and manipulation using Python scripts.
13. Design a graphical user interface to capture input and store data in database tables, performing insert, update, delete, and select operations through the GUI.

TEXT BOOK:

1. Allen B. Downey,*Think Python: How to Think Like a Computer Scientist*, O'Reilly Media, 2024.
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython, Second edition (27 October 2017), Shroff/O'Reilly, ISBN-10: 9789352136414, ISBN-13: 978-9352136414.
3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016.
4. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010.
5. Adi Adhikari and John DeNero, "Computational and Inferential Thinking: The Foundations of Data Science", e-book.

26CSC183 Digital Electronics Lab 0 0 2 1

List of Experiments:

1. Realization of basic gates using Universal logic gates.
2. Code conversion circuits- BCD to Excess-3 and vice-versa.
3 Four-bit parity generator and comparator circuits.
4. Construction of simple Decoder and Multiplexer circuits using logic gates.
5. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.
6. Construction of simple arithmetic circuits-Adder, Subtractor.
7. Realization of RS-JK and D flip-flops using Universal logic gates.
8. Realization of Universal Register using JK flip-flops and logic gates.
9. Realization of Universal Register using multiplexer and flip-flops.
10. Realization of Asynchronous Up/Down counter.
11. Realization of Synchronous Up/Down counter.
12. Realization of Ring counter and Johnson's counter.
13. Construction of adder circuit using Shift Register and full Adder.

22AVP103 Mastery Over Mind (MAOM) 1-0-2 2

Course Overview

MasterOvertheMind(MAOM)isanAmritainitiativetoimplementschemesandorganiseuniversity-wide programs to enhance healthand wellbeing of all faculty, staff, and students (UN SDG-3). This programas part ofour efforts for sustainable stress reductiongives an introductionto immediate and long-term benefits and equips every attendee to manage stressful emotions and anxiety facilitating inner peace and harmony.

With a meditation technique offered by Amrita Chancellor and world-renowned humanitarian and spiritual leader, SriMataAmritanandamayiDevi(Amma), thiscoursehas beenplannedto beofferedtoallstudentsofallcampusesofAMRITA,startingoffwithallfirst years,whereinonehourperweek iscompletelydedicated for guided practicalmeditationsessionand one houronthe theoryaspectsof MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series frometminent personalities fromdiverse fields of excellence. This course willenhancetheunderstandingofexperientiallearningbasedonuniversity's mission:"Educationfor Life along with Education for Living", and is aimed to allow learners to realize and rediscover the infinite potential of one's true Being and the fulfilment of life's goals.

Course Syllabus

Unit 1(4hours)

CausesofStress: The problem of not being relaxed.Need formeditation-basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense ofcontrol and autonomy in the Universal Human Value System. Different stages of Meditation. Various MeditationModels.VariouspracticesofMeditationtechniquesindifferent schoolsofphilosophyand Indian Knowledge System.

Unit 2 (4hours)

Improving work and study performance. Meditation in daily life. Cultivating compassion and good mental health with an attitude of openness and acceptance. Research and Science of Meditation: Significance of practising meditation and perspectives from diverse fields like science, medicine, technology. philosophy, culture, arts, management, sports, economics, healthcare, environment etc. The role of meditation for stress and anxiety reduction in one's life with insights based on recent cutting-edge technology. The effect of practicing meditation for the wholesome wellbeing of an individual.

Unit 3 (4hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approachinmanagingand maintaining betterrelationshipsinlifeduringtheinteractionsintheworld, role of MAOM in developing compassion, empathy and responsibility, instilling interest, and orientation to humanitarian projects as a key to harness intelligence and compassion in youth. Methodologiesto evaluateeffectiveawarenessand relaxationgained frommeditation.Evaluatingthe global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXTBOOKS:

1. MataAmritanandamayiDevi, "CultivatingStrengthandvitality,"published by Mata Amritanandamayi Math, Dec 2019
2. SwamiAmritaswarupanandaPuri,"TheColorofRainbow"publishedbyMAM,Amritapuri.

REFERENCES:

1. CraigGroeschel, "WinningtheWar inYourMind:ChangeYourThinking,ChangeYourLife" Zondervan Publishers, February 2019
2. RNagarathnaet al,"NewPerspectives inStressManagement"SwamiVivekanandaYoga Prakashana publications, Jan 1986
3. SwamiAmritaswarupanandaPuri"AwakenChildrenVol1, 5and7- DialogueswithAmma on Meditation", August 2019
4. SwamiAmritaswarupanandaPuri"FromAmma's Heart-Amma'sanswerto questionsraised during world tours" March 2018
5. SecretofInnerPeace-SwamiRamakrishnanandaPuri,AmritaBooks,Jan2018.
6. MataAmritanandamayiDevi"Compassion:Theonlywayto Peace:ParisSpeech", MA

Center, April 2016.

7. MataAmritanandamayiDevi"UnderstandingandcollaborationbetweenReligions", MA Center, April 2016.

8. MataAmritanandamayiDevi"Awakening ofUniversalMotherhood:GenevaSpeech"M A center, April 2016.

Evaluation and Grading

Internal			**External**	**Total**
Components	*Weightage*		Practical(attendanceandclass participation)60%	100%
Quizzes(basedonthereading material)	20%	40%		
Assignments(Basedon webinarsandlectureseries)	20%			

Course Outcomes (CO)

CO1: Relatetothecausesofstressinone's life.

CO2: Experimentwitharangeofrelaxationtechniques

CO3:Model a meditative approach to work, study, and life.

CO4: DevelopappropriatepracticeofMA-OMtechniquethatiseffectiveinone's life

CO5: Inculcate a higher level of awareness and focus.

CO6:Evaluatetheimpactofameditationtechnique

***Programme Outcomes(PO) (AsgivenbyNBAandABET)**

PO1: EngineeringKnowledge

PO2: ProblemAnalysis

PO3: Design/DevelopmentofSolutions

PO4: ConductInvestigationsofcomplexproblems

PO5: Moderntoolsusage

PO6: EngineerandSociety

PO7: EnvironmentandSustainability

PO8: Ethics

PO9: Individual&Teamwork

PO10: Communication

PO11: Projectmanagement&Finance

PO12: Lifelonglearning

CO–PO Affinity Map

PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**P**	**PS**	**PS**

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**1**	**1**		**O**	**O**

										0	**1**	**2**	**S0 1**	**2**	**3**
CO1	3	3	3	2		-	2	3	-	3	-	3	-	-	-
CO2	3	3	3	2	2	_	2	3	3	3	-	3	-	-	-
CO3	3	3	2	2	2	2	2	3	3	3	-	3	-	-	-
CO4	3	3	3	2	-	2	3	3	3	3	-	3	-	-	-
CO5	3	2	2	2	-	2	-	3	2	2	-	2	-	-	-
CO6	3	2	2	2	3	2	_	3	2	2	-	2	-	-	-

SEMESTER 3

26CSC201 DATA STRUCTURES 3 1 0 4

Course Outcomes	
CO1	Understand the basic concepts of data and growth functions
CO2	Understand the elements of Data structures and its applications
CO3	Understand linked list and types of linked list, performance and applications
CO4	Understand various types of trees and graph structures with applications
CO5	Understand various types of searching and sorting techniques.

Unit I : Introduction – Variables – Data types – Data structures – Abstract Data Type (ADT)- Algorithm – Analysis of Algorithm – Run time Analysis – Rate of Growth – Commonly used Rate of Growth – Types of Analysis – Asymptotic Notations – Why Asymptotic Analysis – Properties of Notations – Master theorem.

Recursion and Back tracking – Recursion Vs Iteration – Problems on Recursion and Back tracking **(12 hrs)**

Unit II : Basic ADT- lists – Array implementation of Lists – Pointer implementation of lists – comparison.

Elementary Data structures – Performance of Basic data structures - Implementation of ADT Stack – Application of Stack – Conversion of infix to postfix expression- Evaluation of Postfix expression -, Queue, Deqeue – Applications – Implementation of Queue and Dequeue.

(12 hrs)

Unit III : Linked List – Linked List ADT – Why Linked List – Comparison of Linked list with Arrays and Dynamic Arrays – Singly Linked List – Operations – Doubly Linked List – Operations – Circular Linked list – Operations – Applications. **(10 hrs)**

Unit IV : Trees – Terminologies – Tree Nodes – Binary Trees – Types – Applications - Traversals – N-ary Trees – Threaded Binary Trees – Binary Search Trees – Applications- Balanced Binary Search Tree – AVL Trees – Priority Queues and Heaps – 2-3-4 Trees.

Graphs – Directed and Undirected Graphs – Graph Representation – Graph Traversal –Articulation Point and Biconnected Components - Transitive Closure-Shortest Paths- Dijkstra's, Bellman Ford, FlyodWarshall-Minimum Spanning Tree – Kruskal, Prims', Baruvka's. **(12 hrs)**

Unit V : Searching and Sorting - Linear Search- Binary Search –Sorting – Selection- Bubble – Insertion – Quick Sort – Merge sort. Symbol Tables and Hashing – Hash Table – Hash Functions – Collision –Collision Resolution techniques. **(10 hrs)**

Text Books:

1. Narasimha Karumanchi, "Data and Algorithms Made Easy", Career Monk publications, 2023.
2. Miller and Rannum , "Problem Solving with Algorithms and Data Structures using Python",
3. Thomas H.Cormen,CharlesE.Liserson,RonaldD.Rivest,Clifford Steins, Introduction to Algorithms, third edition,MIT Press, 2009
4. Benjamin Baka, Python Data Structures and Algorithms, Packt Publishing Ltd, 2017.
5. Ellitz Horowitz, Sarataj Sahini, Senguthevar Rajasekaran, Computer Algorithms, 2nd edition, Silicon Press, 2008.

Reference Books

1. Alfred V Aho, John E Hopcroft, Jeffrey D Ullman. Data Structures & Algorithms, Pearson Publishers, 2002
2. Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Python, Wiley, 2021, 6th edition.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3						2
CO2	3	3	3	3	3	3						2
CO3	3	3	3	3	3	3						2
CO4	3	3	3	3	3	3						2
CO5	3	3	3	3	3	3						2

26MAT202 Optimization Techniques 3 1 0 4

Course Description: This course deals with the fundamentals of single- and multivariable optimization using calculus and numerical-based optimization techniques. Topics include single variable optimization: optimality criteria, region elimination methods, and gradient-based methods. Multivariable optimization: including optimality criteria, gradient-based methods, conjugate methods, and multivariable optimization with equality and inequality constraints, along with their applications.

Course Outcomes:

CO1. Understand different types of single variable optimization techniques in science and engineering optimization problems. Apply single-variable optimization methods, such as calculus and region elimination methods, to find the optimum of single-variable optimization problems.
CO2. Apply the gradient-based methods for single-variable and multivariable optimization problems.
CO3. Understand the unconstrained multivariable optimization problems with the calculus method. Additionally, apply various multivariable optimization methods to find the optimum of unconstrained optimization problems.
CO4. Study the multivariable optimization with equality and inequality constraints. Also, understand how to apply the graphical, Lagrange and Kuhn-Tucker techniques for finding the optimum constrained optimization problems.
CO5. Understand the linear and nonlinear stochastic optimization programming problem. Also, learn the special algorithms such as Genetic algorithm and particle swarm optimization

Unit I: Introduction to optimization: classical optimization, Optimality criteria – Necessary and sufficient conditions for existence of optimum point. Fundamental regionelimination rules to eliminate a region. One-dimensional Search methods: Golden search method, Fibonacci method, Newton's method, Secant method.

Unit II: Unconstrained Multivariable optimization: Introduction, Necessary and sufficient conditions for existence of extreme point. Remarks on line search method. Gradient-based methods- introduction, the gradient based directions, the method of steepest descent, convergence. Analysis of Newton's method**.**

Unit III: Newton's method for nonlinear least-squares. Introduction -The conjugate direction, the conjugate direction algorithm, The conjugate gradient algorithm for unconstrained optimization problems.

Unit IV: Nonlinear equality constrained optimization- Introduction, Problems with equality constraints: problem formulation, Regular point, Tangent and normal spaces, Direct substitution method, Lagrange multiplier method.

Unit V: Nonlinear inequality constrained optimization -Introduction-Linear programming problem, Graphical method. Problems with inequality constraints: Kuhn-Tucker conditions. Linear and nonlinear stochastic programming. Specific search algorithms: Genetic algorithm and particle swarm optimization method.

Lab Experiments:

1. Identifying definiteness of matrices using eigenvalues and use of Hessian matrix to identify concavity of the surfaces (revision from Calculus and Linear Algebra).
2. Implementation of Golden Section Search, Fibonacci search for single variable optimization problems.
3. Evaluation of ordinary and partial derivatives numerically (in excel/MATLAB).
4. Implementation of Secant method and Newton's method for single variable optimization problems.

5. Implementation of evolutionary search method for multivariable optimization problems.
6.Implementation of Cauchy Steepest method for solving multivariable optimization problems.
7. Implementation of Newton's method for solving multivariable optimization problems.
8.Identifying whether a constrained optimization problem is convex or not and solutions using 'cvx'.

Textbooks:

1. Edwin K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", 2nd edition, Wiley, 2021.
2. S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, Fourth edition, 2009.

References:

1. Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2012.
2. Mokhtar S. Bazarra, Hamit D Sherali, C.M. Shetty, "Nonlinear programming Theory and applications", 2nd edition, Wiley, 2004.
3. Mohan C. Joshi, Kannan M. Moudgalya, Optimization: Theory and Practice, Narosa Publishing House, New Delhi, 2004.
4. Bertsimas, Dimitris, and John Tsitsiklis. Introduction to Linear Optimization. Belmont, MA: Athena Scientific, 1997.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2		1							
CO2	3	2	1		1							
CO3	2	3	2		1							
CO4	2	2	1		1							
CO5	2	2	1		1							

26MAT203 Probability Theory 3 1 0 4

Course Description: This course introduces the fundamental concepts of probability and statistics essential for practical applications. It covers probability theory, random variables, standard probability distributions, and Chebyshev's inequality for real-world modelling. The course also examines joint random variables, correlation, and covariance using practical data. Further, it emphasizes sampling distributions and the Central Limit Theorem to understand the behaviour of sample statistics for inference and decision-making under uncertainty.

Course Outcomes: After successful completion of the course, students will be able to

1. Understanding the foundations of probability theory and exploring the relationship between events.
2. Studying the behavior of random variables and their distributions and properties.
3. Understand the real time problems and the statistical distributions that will often be
4. Used for modelling and applications Chebyshev' sinequality.

5. Investigating the joint behaviour of multiple random variables and their relationship using real time data.
6. Understanding the behaviour of sample statistics, Samplingdistributions and Central Limit Theorem

Unit 1

Sample Space and Events, Interpretations and Axioms of Probability, Addition rules, Conditional Probability, Multiplication and Total Probability rules, Independence, Bayes theorem.

Unit 2

Random variables, Probability Distributions and Probability mass functions, Cumulative Distribution functions, mathematical expectation, variance, moments and moment generating function.

Unit 3

Standard discrete distributions - Binomial, Poisson, Uniform, Geometric distributions, Negative binomial and Hypergeometric Distributions -Standard continuous distributions - Uniform, Exponential, Gamma, Beta and Normal distributions. Chebyshev's theorem.

Unit 4

Two dimensional random variables -Joint, marginal and conditional probability distributions for discrete and continuous cases, independence, expectation of two dimensional random variables - conditional mean, conditional variance, covariance and correlation.

Unit 5

Functions of one and two random variables. Sampling and sampling Distributions- t, F and Chi square distributions. Central limit theorem.

Text Books:

1. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, 6th Edition, John Wiley and Sons Inc., (2017)
2. V. K. Rohatgi and A. K. Md. E. Saleh, An Introduction to Probability and Statistics, 3rd Edition, Wiley, (2025)
3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson Education Asia, (2024).

References

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 6th edition, Elsevier Academic Press, (2021)
2. Ravichandran, J. Probability and Statistics for engineers, New Edition, Wiley India, 2023.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	2	2	2									
CO3	2	2	2									
CO4	2	2	1									
CO5	3	2	1									

26MAT204 Numerical Methods 3 1 0 4

Course Description: This course introduces several techniques of numerical methods, algorithms for finding roots of equations or system of equations, Interpolation, Numerical differentiation, Numerical Integration, decomposing matrices, solving differential equations numerically.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Find roots of transcendental and nonlinear equations.
CO2. Interpolate the given data; compute numerical derivatives and numerical integrations.
CO3. Perform matrix related methods in solving linear equations and finding eigenvalues.
CO4. Apply single step, multistep and finite difference methods to solve ODE and PDE.

Unit 1

Roots of Transcendental and Polynomial Equations: Incremental Search Method, Method of Bisection, Methods Based on Linear Interpolation, Newton-Raphson Method, Systems of nonlinear Equations.

Unit 2

Interpolation: Lagrange, Newton's Divided Difference, Newton's Forward and Backward interpolations and cubic splines. Differentiation and Integration: Numerical differentiation, Maxima and Minima, Numerical integration, Newton-Cotes formulas, Romberg integration, Gaussian integration,

Unit 3

Solution of System of Linear Algebraic Equations, Gauss-Elimination, LU Decomposition, Iterative methods: Pivoting, Gauss-Seidel.

Eigenvalues and Eigenvectors: Jacobi Method for symmetric matrices, Power method and Inverse Power Methods for arbitrary matrices.

Unit 4

Solutions of Ordinary Differential Equations: Initial Value problems, Euler methods, Modified Euler method and Fourth order Runge-Kutta method. Finite difference methods. Boundary value problems using Forward Difference operators. First order PDE, Solutions of Partial Differential equations: Elliptic, Parabolic equations.

Text Books:

1. Numerical Methods in Engineering with Python, Jaan Kiusalaas, Cambridge University Press, 2010.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and Engineering computation, New Age International Publishers, 2007, 5th edition.

Reference Books:

1. R.L. Burden, J. D. Faires, Numerical Analysis, Richard Stratton, 2011, 9th edition.
2. S.D. Conte and Carl de Boor, 'Elementary Numerical Analysis; An Algorithmic Approach'. International series in Pune and Applied Mathematics, McGraw Hill Book Co., 1980.
3. S. S. Sastry, Introductory methods of Numerical Analysis, 2012, PHI Publishers, 5th edition,

Evaluation Pattern

Continuous Evaluation (Theory + Lab Assignments)	30%
One mid-term examination	30%
End-semester examination	40%

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2							
CO2	3	2	3	1	2							
CO3	3	2	3	1	2							
CO4	3	2	3	1	2							
CO5	3	2	3	1	2							

26CSC202 DATABASE MANAGEMENT SYSTEMS 3 0 2 4

Course Description:

This course provides a comprehensive introduction to Database Management Systems, focusing on both theoretical and practical SQL applications. The course explores concepts such as Data Models, Entity–Relationship diagrams, Relational Algebra, Normalization, Transaction management and concurrency control. The laboratory component offers hands-on experience in creating databases, executing queries, implementing triggers and views, utilizing indexing methods, and addressing real – world database design issues.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Understand the basic concepts of Database Management Systems, including data models, relational structures, database languages, and relational algebra.
CO2. Construct Entity–Relationship diagrams and convert E-R diagrams into relational schemas while applying appropriate key and mapping constraints.
CO3. Construct and execute SQL queries using basic, intermediate, and advanced SQL features including joins, nested subqueries, views, triggers, transactions, and integrity constraints.
CO4. Analyse and apply normalization techniques using functional and multivalued dependency theory to design efficient and redundancy-free relational database schemas.
CO5. Implement transaction management and concurrency control mechanisms, including serializability and lock-based protocols, to ensure data consistency and reliability.

Unit 1 : Introduction to DBMS: Database systems applications - Purpose of database systems – View of Data – Database Languages. Relational Languages: Structure of relational databases – Database

schema - Keys – Schema diagrams. Relational Query Languages – Relational Algebra. Introduction to SQL: Overview – SQL Data definition – Basic Structure of SQL queries –Additional Basic Operations - Set operations – Null values - Aggregate functions – Nested Subqueries – Modification of the Database.

Unit 2 : Database Design - Overview of the design process – The Entity-Relationship Model – Complex Attributes – Mapping Cardinalities – Primary Key – Reducing E-R Diagrams to Relational Schemas - Extended E-R Features Entity-Relationship Design Issues. Intermediate SQL: Join Expressions – Views – Transactions – Integrity Constraints – SQL Data Types and Schemas - Authorization. Advanced SQL – Accessing SQL from a Programming Language – Functions and Procedures – Triggers.

Unit 3 : Relational Database Design – Features of Good Relational Designs – Decomposition using Functional Dependencies – Normal Forms :1NF, 2NF, 3NF, 4NF and BCNF- Functional Dependency Theory – Algorithm for Decomposition using Functional Dependencies -Decomposition using Multivalued Dependencies – More Normal Forms: PJNF and DKNF. Complex Data Types: Semi-Structured Data.Transaction Management: Transactions – A simple Transaction Model – Transaction Atomicity and Durability – Transaction Isolation – Serializability – Concurrency Control: Lock Based Protocols.

Suggested lab exercises:

1. Working with SQL queries for the following

(i) Data Definition Language: Create, Alter, Grant, Revoke, Drop, Truncate.
(ii) Data Manipulation Language: Select, Insert, Update, Delete.
(iii) Transaction Control Statements: Commit, Rollback, Save point.

2. Working with Constraints and keys in SQL.
3. Apply Functions: String functions, Aggregate functions, Group by, Order by, Date and Conversion Functions.
4. Set operators, Joins, Sub query: Simple, Nested, Correlated, Existence test, Membership test, DDL and Sub queries and DML.
5. Working with other schema objects: View, Sequence, Index, Synonym, Cluster, Lock, BLOB, CLOB, Nested table, Type.
6. PL/SQL programs, cursors, functions, procedures, packages, triggers, exception handling.
7. Working with Complex Data Types
8. Front end tool: Form creation, Validation, Trigger and Report generation.

Text Book:

1. Silberschatz. A., Korth, H. F. and Sudharshan, S. “Database System Concepts”, 7th Edition, Tata Mc Graw Hill Publishing, 2020.

Reference Books

1. Elmasri, R. and Navathe, S. B. “Fundamentals of Database Systems”, 7th Edition, Addison Wesley, 2017
2. Date, C. J. “An Introduction to Database Systems”, 8th Edition, Addison Wesley, 2003.

3. Ramakrishnan, R. and Gehrke, J. “Database Management Systems”, 3rd Edition, McGrawHill, 2003.
4. Bipin C Desai, “An introduction to Database Systems”, Galgotia Publications, 2012

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	2	3				2	2	3
CO2	2	2	2	2	2	2				2	2	2
CO3	2	3	2	2	3	3				2	2	2
CO4	2	3	2	2	2	2				2	3	2
CO5	2	3	2	3	2	2				3	2	2

23ENV300 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY P/F

Course Objectives

• To study the nature and facts about environment

• To appreciate the importance of environment by assessing its impact on the human world

• To study the integrated themes and biodiversity, pollution control and waste management

Course Outcomes

CO1: Ability to understand aspects of nature and environment

CO2: Ability to analyse impact of environment on human world

CO3: Ability to comprehend pollution control and waste management

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	0	1	1	1	0	1	1	1	1	1
CO2	1	1	0	1	1	1	1	1	2	1	1	1
CO3	1	1	0	1	1	1	1	1	2	1	1	1

Unit 1

Over view of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related International conventions and treaties and regulations – Overpopulation – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

Unit 2

Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land, thermal, noise).

Unit 3

Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

Text Book(s)

R. Rajagopalan,"Environmental Studies – From Crisis to Cure", Oxford University Press, 2005, ISBN 0-19-567393-X.

Reference(s)

G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.

Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

23LSK201 Life Skills I 1-0-2-2

Pre-requisite: A nopenmindandtheurge for self-development, basic English language skills,knowledge of high school level mathematics.

Course Objective: To assist students in inculcating soft skills, developing strong personality, empowering them to face life's challenges, improving their communication skills and problem-solving skills.

CourseOutcomes

CO1: Soft Skills-To develop greater morale and positive attitude to face, analyze, and manage emotions in real life situations, like placement process.
CO2: Soft Skills - To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and over coming nervousness, in situations like presentations, Group Discussions and interviews.

CO3: Aptitude –Toanalyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.

CO4:Aptitude-Toinvestigateandapplysuitabletechniquestosolvequestionsonlogicalreasoning.

CO5: Verbal–To infer the meaning of words & use them in the right context. To have a better understandingofthenuancesof English grammar and become capable of applying them effectively.

CO6: Verbal-To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

Skills: Communication,self-confidence,emotionalintelligence,presentationskillsandproblem-solvingSkills.

CO-POMapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	2	3	3	-	3
CO2	-	-	-	-	-	-	-	3	2	3	-	3
CO3	-	3	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	3

Soft Skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticismsand feedback. Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing one self, Self- perception, Importance of positive attitude, Building and dis playing confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity- Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Squareroots, Cube Roots and Simplification.

Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest. **Ratio, Proportion &Variation:** Basics, Alligations, Mixtures, and Partnership. **Averages:** Basics, and Weighted Average.

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problem son ages.

Logical Reasoning I: Blood Relations, Direction Test, Syllogisms, Series, Odd manout, Coding\&Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal Skills

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and en able them to answer synonymandantonymquestions.Createanawarenessaboutthefrequentlymisusedwords,commonly confusedwords and wrong form of words in English.

Grammar(Basics): To learn the usage of grammar and facilitate students to identify errors and correct them.

Reasoning: Stress the importance of understanding the relationship between words through analogy questions. Emphasize the importance of avoiding the gap (assumption) in the argument/ statements/ communication.

Speaking Skills: Make students conscious of the relevance of effective communication in today's world through individual speaking activities.

Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

References:

1. Gulati.S.,(1006)"Corporate Soft Skills",New Delhi, India:Rupa&Co.
2. The hard truth about Soft Skills,byAmazon Publication.
3. Verbal Skills Activity Book, CIR, AVVP
4. Nova'sGREPrep Course ,Jeff Kolby, Scott Thornburg & Kathleen Pierce
5. The BBC and British Councilonlinere sources
6. Owl Purdue University online teach in gresources
7. www.thegrammarbook.comonlineteach in gresources
8. www.englishpage.comonlineteachingresourcesandotherusefulwebsites
9. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, AbhijitGuha.
11. How to Preparefor Quantitative Aptitudefor the CAT, ArunSharma.
12. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
13. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
14. Quantitative Aptitude for Competitive Examinations, RS Aggarwal.
15. A Modern Approach to Logical Reasoning, RS Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, RSAggarwal.

Evaluation Pattern

Assessment	Internal	External
ContinuousAssessment(CA)*–SoftSkills	30	-
ContinuousAssessment(CA)*–Aptitude	10	25
ContinuousAssessment(CA)*–Verbal	10	25
Total	50	50

*CA-Can be **presentations, speaking activities and tests.**

SEMESTER 4

26MAT211 Statistical Inference Theory 3 0 0 3

Course Description: This course focuses on statistical estimation and inference techniques used in data science and research applications. It covers point estimation methods including maximum likelihood and method of moments, along with properties of estimators. The course introduces interval estimation and hypothesis testing for means, proportions, and variances under both large and small sample conditions. It also includes chi-square tests and non-parametric methods for real-world data analysis. The course equips students with analytical skills for statistical decision-making under uncertainty.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Apply principles of point estimation to determine unbiased, consistent, sufficient, and efficient estimators using methods of moments and maximum likelihood.

CO2: Construct and interpret confidence intervals for population parameters including means, proportions, and variances under different conditions.

CO3: Perform large sample hypothesis tests for means and proportions to support statistical decision-making.

CO4: Conduct small sample tests including t-tests, paired t-tests, and F-tests for variances to analyze limited data samples.

CO5: Apply chi-square tests and some non-parametric tests to assess goodness of fit, independence, and homogeneity in real-world data.

Unit 1: Estimation theory - Point Estimation - Introduction- criteria of point estimation, unbiasedness, consistency, sufficiency, and efficiency of various distributions, method of maximum likelihood estimation and method of moments – minimum risk estimators.

Unit 2 : Interval Estimation: Introduction - confidence Interval for mean of a Normal Distribution with Variance known and unknown - Confidence Interval for the two means of a Normal Distribution with Variance known and unknown, Confidence interval for one and two Population Proportions, Confidence interval for the variance and ratio of variances.

Unit 3 : Inference theory - introduction to hypothesis testing - large sample tests for single mean and two means - large sample tests for single proportion and two proportions.

Unit 4 : Small sample tests for single mean and two means – paired t-test - test for single variance – test for equality of two variances.

Unit 5 : Chi-square goodness of fit for Binomial, Poisson and Normal distributions, Independence of attributes, test for homogeneity, Non-parametric tests - sign test, signed rank test and Mann Whitney U test.

Text Books:

1. George Casella & Roger L. Berger, Statistical Inference, Chapman & Hall/CRC Texts (2024).
2. Pradip Kumar Sahu, Santi Ranjan Pal & Ajit Kumar Das, Estimation and Inferential Statistics, (2016).

3. Friedrich Liese and Klaus-J. Miescke, Statistical Decision Theory: Estimation, Testing, and Selection, Springer Series in Statistics, (2010)

References

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 6th edition, Elsevier Academic Press, (2021)
2. Ravichandran, J. Probability and Statistics for engineers, New Edition, Wiley India, 2023.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								
CO2	3	3	2	2								
CO3	3	3	2	3								
CO4	3	3	1	3								
CO5	3	2	1	3								

26MAT212 Convex Optimization 3 0 0 3

Course Description: This course introduces the fundamentals of convex sets and convex functions to study the convex optimization problems. Also, the different types of linear and nonlinear constrained optimization problems with their methods are included. Topics include various optimization problems for linear and nonlinear programming problems, affine and convex sets with their important properties, convex functions and their special types of functions, convex optimization, geometric programming, dual and Lagrange dual functions with equality and inequality constraints, along with their applications.

Course Outcomes: After successful completion of this course, students will be able to

CO1. Understand the basic concepts and different types of optimizations related to linear as well as nonlinear problems in engineering. Learn the concept of affine and convex sets and their importance.

CO2. Understand the properties, generalized inequalities, and operations that preserve convexity in convex sets as well as convex functions. Learn the concepts of separating and supporting hyperplanes, dual cones, and generalized inequalities.

CO3. Understand and learn the applications for the different optimization problems such as convex optimization, optimization problems, linear optimization, quadratic optimization, geometric programming, generalized inequality constraints, and vector optimization.

CO4. Understand the duality and Lagrange dual function problem. Learn the geometric interpretation, saddle point interpretation, perturbation, sensitivity analysis, generalized inequalities, and their applications.

Unit I: Introduction: Mathematical optimization, Convex optimization, Least-squares and linear programming, Simplex method, Two phase method, Integer linear programming, Nonlinear optimization.

Unit II: Convex sets: Affine and convex sets. Some important examples. Operations that preserve convexity. Generalized inequalities. Separating and supporting hyperplanes. Dual cones and generalized inequalities.

Unit III: Convex functions: Basic properties and examples. Operations that preserve convexity. The conjugate function. Quasi-convex functions. Log-concave and log-convex functions. Convexity with respect to generalized inequalities.

Unit IV: Convex optimization problems. Optimization problems. Convex optimization. Linear optimization problems. Quadratic optimization problems. Geometric programming. Generalized inequality constraints. Vector optimization.

Unit V: The Lagrange dual function. The Lagrange dual problem. Geometric interpretation. Saddle-point interpretation. Optimality conditions. Perturbation and sensitivity analysis. Theorems of alternatives. Generalized inequalities.

Textbooks:

1. Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2009.

References:

1. Dimitri P. Bertsekas, Convex Optimization Theory, University Press, 2016.
2. Hamdy A. Taha, "Operations Research-An Introduction", Prentice Hall, 9th Edition, 2010.
3. Edwin K.P. Chong, Stanislaw H. Zak, "An Introduction to Optimization", 2nd edition, Wiley, 2021.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2		2	1	1						3	2
CO2	1	1	1	3	3						3	2
CO3		1		2	1						3	2
CO4			2	2	3						3	2
CO5	2		2	1	1						3	2

26CSC211 **Machine Learning** **3 0 0 3**

Course Outcomes	
CO1	Understand fundamental concepts of machine learning
CO2	Apply classification and regression techniques to real-world problems
CO3	Analyze and implement probabilistic and instance-based learning methods.

CO4	Evaluate and improve model performance using advanced techniques
CO5	Perform unsupervised learning and dimensionality reduction.

Unit I: Introduction: Well-Posed Learning Problems, Designing a Learning System, A Concept Learning Task, Concept Learning as Search, Find-S: Finding a Maximally Specific Hypothesis, Version spaces and the Candidate-Elimination algorithm, Inductive Bias. Validation Metrics. Introduction to types of learning: Supervised learning, Semi-Supervised Learning, Unsupervised learning, and Reinforcement Learning.

Unit II Classification and Regression: Learning a class from training, linear, nonlinear, multi-class, and multi-label classification. Regression: Simple Linear Regression, Multiple linear regression, Logistic Regression, Polynomial, and Ridge and Lasso Regression. Decision Tree learning: Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Issues in decision tree learning, Classification and Regression Trees (CART), Random Forest. Validation Metrics for Classification and Regression.

Unit III: Bayesian Learning: Naïve Bayes classifier. Instance-Based Learning: K-Nearest Neighbour Learning, Radial Basis Functions, Support Vector Machines: The Margin and Support Vectors, linear and Nonlinear Kernels.

Unit IV: Cross Validation (CV) and resampling. Ensemble Learning: Ensemble Learning Model Combination Schemes, Maximum Voting, Averaging, Weighted Averaging, Bagging: Random Forest Trees, Boosting: Gradient Boosting, Adaptive Boosting, Extreme Gradient Boosting, XG Boosting,Adaboost, Stacking.

Unit V: Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction: Principal Component Analysis (PCA) and kernel PCA. Matrix Factorization and Matrix Completion. Expectation Maximization, Gaussian Mixture Models, Case Study.

TEXT BOOKS

1 Tom M. Mitchell, Machine Learning, McGraw-Hill, 1997.
2 Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, 3rd Edition, 2014.
3 Stephen Marsland, Machine Learning: An Algorithmic Perspective, Taylor & Francis (CRC), 2014.
4 Peter Flach, Machine Learning, Cambridge University Press, 2012.

REFERENCES

1 Haroon D, Python Machine Learning Case Studies, Apress, 2017.
2 Harrington, P, Machine learning in action, Manning Publications Co., 2012.
3 Richard O. Duda, Peter E. Hart, and David G. Stork, Pattern classification, John Wiley & Sons, 2001.

26CSC282 Machine Learning Lab 0 0 2 1

Course Outcomes (COs):

Course Outcomes	
CO1	To implement modern machine learning model of supervised learning.
CO2	To implement modern machine learning model of unsupervised learning.

- Data pertaining methods
- Methods for removing noises and out layers.
- Simple and multi-regression models
- Decision tree and Random forest models.
- Ensemble Learning Models.
- Bayesian Learning Models
- Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction:

CO–PO Mapping:

Course Outcomes	
CO1	Understand asymptotic notations and run time analysis
CO2	Understand divide and conquer strategy
CO3	Understand Greedy and Dynamic programming strategy algorithms
CO4	Understand Back tracking and branch bound strategy
CO5	Understand computational complexities

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3								3
CO2	2	2	2	3								3

26CSC212 DESIGN AND ANALYSIS OF ALGORITHMS 3 0 2 4

Unit I: Introduction: Problem solving -- adding 2 n-bit numbers, multiplication as repeated addition. Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case **(12 hrs)**

Unit II : Divide and Conquer – Analysis of: Binary Search — Merge sort — Quick sort — Heap Sort — Multiplication of Large Integers — Closest-Pair and Convex — Hull Problems. **(10 hrs)**

Unit III : Greedy Technique – General Method – Analysis of: fractional Knapsack Problem – Job Sequencing with Deadlines – MST –Single Source shortest path.

Dynamic Programming – General Method – Analysis of: Multistage Graphs, all pair shortest path, Matrix chain multiplication,0/1 Knapsack problem, Travelling Salesman Problem **(12 hrs)**

Unit IV : Backtracking – General Method – Analysis of: 8 Queens Problem – Sum of Subsets – Graph Coloring – Hamiltonian Cycles – Knapsack Problem.

Branch and Bound – General Method – Analysis of: 0/1 Knap sack problem – Travelling salesperson problem – LC Branch and Bound – FIFO Branch and Bound **(12 hrs)**

Unit V : String Matching: Boyer Moore – KMP – Rabin Karp. NP-Hard and NP-Complete Problems: Basic concepts, non-deterministic algorithms, NP-hard and NP-complete classes,Cook's theorem. **(10 hrs)**

Text Book

1. Ellitz Horowitz, Sarataj Sahini, Senguthevar Rajasekaran, Computer Algorithms, 2nd edition, Silicon Press, 2008.
2. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, Third Edition, 2009.
3. Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Python, Wiley, 2021, 6th edition.

Reference Book:

1. Alfred V Aho, John E Hopcroft, Jeffrey D Ullman. Data Structures & Algorithms, Pearson Publishers, 2002
2. Narasimha Karumanchi, "Data and Algorithms Made Easy", Career Monk publications, 2023.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3						2
CO2	3	3	3	3	3	3						2
CO3	3	3	3	3	3	3						2
CO4	3	3	3	3	3	3						2
CO5	3	3	3	3	3	3						2

26CSC213 Data Visualization 3 0 2 4

Course Description:

This course explores the principles of transforming raw data into meaningful visual representations. Topics include fundamental visualization types, data structures, and advanced techniques for

multivariate and high-dimensional data. The practical component covers real-world dataset analysis and interactive dashboard creation using Tableau, Plotly, and Power BI.

Course Outcomes (COs)): After successful completion of the course, students will be able to

CO1	Understand and explain different types of data visualization techniques, their classification, and structural representations.
CO2	Apply principles of multivariate and linked data visualization using plots, cluster analysis, and contingency tables.
CO3	Use visualization methodologies such as Bayesian data analysis, matrix visualization, and kernel machines on given datasets.
CO4	Analyse and interpret domain-specific data from genetic networks, medical images, financial records, and insurance datasets through visualization.
CO5	Build interactive dashboards and data stories using Tableau, Plotly, and Power BI for real-world analytical use cases.

Unit 1 : Introduction to Data Visualization – Classification of Visualization techniques – Structure and representation – Selection of a Visualization – Visualizations for high dimensional data – Graphics and computing.

Principles of Data Visualization: Multivariate data – Linked data – Visualizing trees and forests – Large Datasets – Plots and their variates – Visualizing cluster analysis – contingency tables – finite mixture models.

Methodologies: Visualization in Bayesian data analysis – Matrix visualization – Data visualization by kernel machines. Applications: Visualization for genetic network reconstruction, medical images, financial dataset and Insurance risk processes.

Tableau: Introduction to Tableau – Advanced visualizations with Tableau – Choropleth Maps – Waffle Charts – Dashboards – Creating Dashboards with Tableau and Plotly. Introduction to POWER BI - Power BI for interactive Analytics-Case studies.

Suggested lab exercises:

1. Visualization using Python libraries and creation of basic charts.
2. Multivariate data visualization using plots and their variates.
3. Interactive exploration of linked data and large dataset with visualization techniques.
4. Plotting hierarchical trees and decision forests and visualization of clusters.
5. Correlation and distance matrices with heatmaps.

6. Plotting Bayesian data analytical results.
7. Visualizing genetic network and medical image data.
8. Risk analysis plots for financial dataset and insurance risk
9. Interactive Dashboard Building with filters, sliders, and dynamic plots.
10. Choropleth Maps and Waffle Charts in Tableau.
11. Importing and visualizing data using Power BI.
12. Case study: End-to-end data visualization pipeline using any one tool.

Text Books

1. Claus Wilke, Fundamentals of Data Visualization – A Primer on Making Informative and Compelling Figures, O'Reilly Media Publisher, 2019.
2. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, and Jeffrey W. Ohlmann, Data Visualization Exploring and Explaining with Data 2021.
3. Usama Fayyad, Georges G. Grinstein and Andreas Wierse, "Information visualization in Data Mining and Knowledge discovery", Morgan Kaufmann publishers, 2002.

References

1. Kieran Healy, Data Visualization a Practical Introduction, Princeton University Press, 2018.
2. Chun-houh Chen, Wolfgang Hardle and Antony Unwin, "Handbook of Data Visualization", Springer, 2008.
3. Tableau for Dummies by Molly Monsey and Paul Sochan
4. Elias Dabbas, "Interactive Dashboards and Data Apps with Plotly and Dash", Packt Publishing, 2021.
5. Jeremey Arnold, "Learning Microsoft Power BI: Transforming Data into Insights", O'Reilly Media, 2022.5.
6. Colin Ware, "Information Visualization: Perception for Design", Morgan Kaufmann / Elsevier, 4th Ed., 2021.
7. Scott Murray, "Interactive Data Visualization for the Web", O'Reilly Media, 2nd Ed., 2017.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1							1	2		2
CO2	3	3	3		2	2			2	2		3
CO3	3	3	3	2	2	2			2	2		3
CO4	3	3	3	3	3	2		2	3	3	2	3
CO5	3	2	3	2	3	3			3	3	3	3

23LSK211 **Life Skills II** **1-0-2-2**

Pre-requisite:
Willingnesstolearn,communicationskills,basicEnglishlanguageskills,knowledge of high school level mathematics.

Course Objective: To help students understand the corporate culture and assist them in improving their group discussion skills, communication skills, listening skills and problem-solving skills.

CourseOutcomes

CO1:SoftSkills-Toimprovethe inter-personal skills, professional etiquette and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities.
CO2: Soft Skills- To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.
CO3: Aptitude-To interpret, critically analyze and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4:Aptitude-To analyze, understand and apply suitable methods to solve questionson logical reasoning.
CO5:Verbal-To be able to use vocabulary in the right context and to be competent ins potting grammatical errors and correcting them.
CO6:Verbal-To be able to logically connect words, phrases, sentences and there by communicate their perspectives/ideas convincingly.
Skills: Communication, etiquette and grooming, inter-personal skills, listening skills, convincing skills, problem-solving skill.

CO-POMapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	2	3	3	2	3
CO2	-	-	-	-	-	-	-	2	3	3	2	3
CO3	-	3	-	-	-	-	-	-	-	-	-	3
CO4	-	3	-	-	-	-	-	-	-	-	-	3
CO5	-	-	-	-	-	-	-	-	-	3	-	3
CO6	-	-	-	-	-	-	-	-	3	3	-	3

Syllabus

Soft Skills

Professional Grooming and Practices: Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and cultural adaptability and managing diversity. Handling pressure, multi-tasking. Being enterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem

solving.

Group Discussions: Advantages of group discussions, Types of group discussion and Roles played in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude

Logarithms, Inequalities and Modulus:Basics
Sequence and Series: Basics, AP, GP, HP and Special Series.
Time and Work: Basics, Pipes & Cistern and Work Equivalence.

Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

Logical Reasoning II: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives, Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.

VerbalSkills Vocabulary: Help students understand the usage of words in different contexts.

Grammar(MediumLevel): TrainStudentstocomprehendthenuancesofGrammar and empower them to spot errors in sentences and correct them.

Reading Comprehension(Basics): Introducestudentstosmartreadingtechniquesandhelpthem understand different tones in comprehension passages.

Reasoning: Enable students to connect words, phrases and sentences logically.

Oral Communication Skills: A id students in using the gift of the gab to interpret images ,do a video synthesis, try a song interpretation or elaborate on a literary quote.

References:

1. Adair. J.,(1.986), "Effective Team Building: How to make a winning team", London, U.K:Pan Books.
2. Gulati.S.,(2006)"Corporate Soft Skills",NewDelhi, India: Rupa&Co.
3. The Hard Truth about SoftSkills,byAmazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GREPrep Course, JeffKol by, Scott Thornburg & KathleenPierce
6. The BBC and British Council on line resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.comonlineteaching resources
9. www.englishpage.comonlineteachingresourcesandotherusefulwebsites
10. Student Workbook: Quantitative Aptitude& Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.

13. How to Prepare for Data Interpretation for the CAT, ArunSharma.
14. How to Prepare for Logical Reasoning for the CAT, ArunSharma.
15. Quantitative Aptitude for Competitive Examinations, RSAggarwal.
16. A Modern Approach to Logical Reasoning, RSAggarwal.
17. A Modern Approach to Verbal &Non-Verbal Reasoning, RSAggarwal.

EvaluationPattern

Assessment	Internal	External
Continuous Assessment(CA)*–SoftSkills	30	-
Continuous Assessment(CA)*–Aptitude	10	25
Continuous Assessment(CA)*–Verbal	10	25
Total	50	50
• CA - Can be presentations, speaking activities and tests		

26CSCXXX Design and Analysis of Algorithms LAB 0 0 2 1

Implement the following program questions in Python code.

1. Implement fractional knapsack problem
2. Implement Implement sum of subsets
3. Construct minimum spanning tree
4. Program for string matching using KMP, Boyer Moore
5. Implement of 0/1 knapsack problem
6. Implement algorithms of shortest path.
7. Implement matrix chain multiplication

AMRITA VALUE PROGRAMMES I & II

22AVP201 Amma'sLife and Message to the Modern World 1 0 0 1

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word, Amma speaks and the guidance received inonmatters which we consider as trivial are rich incontent and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we be come witness to all the happenings around us still keeping the balance of the mind.

22ADM211LeadershipfromtheRamayana

IntroductiontoRamayana,thefirstEpicintheworld–
InfluenceofRamayanaonIndianvaluesandculture

– StorylineofRamayana–StudyofleadingcharactersinRamayana–
InfluenceofRamayanaoutsideIndia

– Relevance of Ramayana for modern times.

22ADM201StrategicLessonsfromtheMahabharata

Introduction to Mahabharata, the largest Epic in the world–Influence of Mahabharata on Indian values and culture–Story line of Mahabharata–Study of leading characters in Mahabharata–Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

22AVP204LessonsfromtheUpanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads- ThecentralproblemsoftheUpanishads–TheUpanishadsandIndianCulture–Relevanceof Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

22AVP205MessageoftheBhagavad Gita

IntroductiontoBhagavadGita–BriefstorylineofMahabharata-ContextofKurukshetraWar– Theanguish of Arjuna–Counsel by Sri. Krishna–Key teachings of the Bhagavad Gita– Karma Yoga, Jnana Yoga and BhaktiYoga- Theory of Karma and Reincarnation– Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206LifeandMessageofSwamiVivekananda

BriefSketchofSwamiVivekananda'sLife–MeetingwithGuru–DiscipliningofNarendra-Travela cross India-Inspiring Life incidents–Address at the Parliament of Religions–Travel in United States and Europe

– Return and reception India–Message from Swamiji's life.

22AVP207 Life and Teachings of Spiritual Masters India 1 0 0 1

Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

22AVP208InsightsintoIndianArtsandLiterature

The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

22AVP209YogaandMeditation

TheobjectiveofthecourseistoprovidepracticaltraininginYOGAASANASwithasoundtheoreticalba se and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

22AVP210KeralaMuralArtandPainting

Mural painting is an off shoot of the devotional tradition of Kerala. A muralis any piece of art work painted or applied directlyona wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9^{th} to12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

22AVP213 Traditional Fine Arts of India 1 0 0 1

India is home to one of the most diverse Art forms world over. The under lying philosophy of Indian life is 'Únity in Diversity" and ithasled to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

22AVP214 Principles of Worship in India 1 0 0 1

Indianmodeofworshipisuniqueamongtheworldcivilizations.Nowhereintheworldhasthephilosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realization of this profound truth. To see theall-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

22AVP215 Temple Mural Arts in Kerala 1 0 0 1

The traditional percussion ensembles in the Temples of Kerala have enthralled millions over the years. The splendor of our temples makes art enthusiast spellbound, warmth and grandeur of color combination sumptuousness of the outline, crowding of space by divine or heroic figures often with in vigorous movement are the characteristics of murals.

The mural painting specially area visual counterpart of myth, legend, gods, dirties, and demons of the theatrical world, Identical myths are popular the birth of Rama, the story of Bhīmaand Hanuman, Shiva, as Kirata, and the Jealousy of Uma and ganga the mural painting in Kerala appear to be closely related to, and influenced by this theatrical activity the art historians on temple planes, wood carving and painting the architectural plane of the Kerala temples are built largely on the pan-Indians almost universal model of the Vasthupurusha.

22AVP218 Insights into Indian Classical Music 1 0 0 1

The course introduces the students into the various terminologies used in Indian musicology and their explanations, like Nadam, Sruti, Svaram – svara nomenclature, Stayi, Graha, Nyasa, Amsa, Thala,-Saptatalas and their angas, Shadangas, Vadi, Samavadi, Anuvadi. The course takes the students through Carnatic as well as Hindustani classical styles.

22AVP219 Insights into Traditional Indian Painting 1 0 0 1

The course introduces traditional Indian paintings in the light of ancient Indian wisdom in the fields of aesthetics, the Shadanga (Sixs limbs of Indian paintings) and the contextual stories from ancient texts from wherethepaintingsoriginated.Thecourseintroducesthepaintingstylessuchas Madhubani, Kerala

Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance 1 0 0 1

The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the Abhinava Bharati. The course introduces various styles of Indian classical dance such as Bharatanatyan, Mohiniyatton, Kuchipudi, Odissy, Katak etc. The course takes the students through both contextual theory as well as practice time.

22AVP221 Indian Martial Arts and Self Defense 1 0 0 1

The course introduces the students to the ancient Indian system of self-defense and the combat through various martial art forms and focuses more on traditional Kerala's traditional Kalari Payattu. The course introduces the various exercise technique to make the body supple and flexible before going into the steps and techniques of the martial art. The advanced level of this course introduces the technique of weaponry.

SEMESTER 5

26CSC301 Operating Systems 3 0 2 4

Course Objectives:

To provide students with a comprehensive understanding of operating system concepts, design principles, and management techniques, enabling them to analyze and apply process scheduling, synchronization, deadlock handling, memory management, and virtual memory mechanisms in modern computing systems.

Course Outcomes:

CO1: Understanding the fundamental concepts of operating systems and structures.
CO2: Analyze CPU scheduling algorithms and process synchronization.
CO3: Understanding the deadlock concepts and recovery techniques.
CO4: Describe the memory management techniques.

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1			1				1		1
CO2	2	3	2			2			1			1
CO3	2	2	3			2			1		1	1
CO4	2	2	3	1		1						1
CO5	3	2	2			2						1

Unit I: Introduction: Operating Systems, Computer-System Organization, Computer-System Organization, Operating-System Operations, Resource Management. **Operating System Structures:** Operating-System Services, System Calls, Operating-System Structure.

Unit II: Process Management: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication. **Threads & Concurrency:** Multicore Programming, Multithreading Models, Implicit Threading, Threading Issues

Unit III: CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms- FIFO, SJFS, Round-Robin, Priority Scheduling. **Process Synchronization:** The Critical-Section Problem, Peterson's Solution, Mutex Locks, Semaphores.

Unit IV: Deadlocks: System Model, Deadlock in Multithreaded Applications, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

UNIT V: Memory Management: Contiguous Memory Allocation, Paging, Structure of the Page Table, Swapping. **Virtual Memory:** Demand Paging, Page Replacement- Basic page replacement, FIFO, Optimal page replacement, LRU.

TEXT BOOK:

1 Silberschatz, A., Galvin, P. B., & Gagne, G. (2019). Operating system concepts. John Wiley & Sons, 10th Edition (Chapter 1 to 10).

REFERENCES:

1 Deitel. Deitel and Choffnes, "Operating System", Third edition, Prentice Hall, 2003.
2 Tannenbaum A S, "Modern Operating Systems", Third edition, Prentice Hall, 2007.
3 Stevens W R and Rago S A, "Advanced Programming in the Unix Environment", Second Edition, Addison-Wesley, 2013.
4 Gary Nutt, "Operating Systems", Third Edition, Pearson Education, 2009.

26MAT301 Multivariate Statistics for Data Science 3 0 2 4

The Organization of Data: Arrays, Descriptive Statistics, Two-Dimensional Scatter Plots, Distance.

Random Vectors and Matrices: Mean Vectors and Covariance Matrices, Geometry of the Sample, Random Samples, Sample Mean and Covariance Matrix and Correlation Matrix, Generalized Variance.

The Multivariate Normal Distribution: Multivariate Normal Density and its Properties, The Sampling Distribution of sample mean $\bar{X}$ and S.

Principal Component Analysis: Principal Components for Covariance Matrices, Sample Variation by Principal Components.

Factor Analysis: The Orthogonal Factor Model, The Principal Component Method.

Discrimination and Classification: Separation and Classification for Two Populations, Classification with Two Multivariate Normal Populations, Classification with Several Populations.

Text Books:

1 Johnson, R.A., and Wichern, D.W. (2007). Applied Multivariate Statistical Analysis. 6th Edition, Prentice Hall, New York.
2 T. W. Anderson (2003), An Introduction to Multivariate Statistical Analysis, 3rd Edition, John Wiley and Sons, New Jersey, USA.

References:

1 Morrison (1990). Multivariate Statistical Methods, McGraw-Hill,
2 Hair, Joseph F.; Black, William C.; Babin, Barry J.; Anderson, Rolph E. Multivariate data analysis, 7th edition, Pearson.

22CSC302 Number Theory and Information Security 3 1 0 4

Algorithms for integer arithmetic: Divisibility, GCD, modular arithmetic, modular exponentiation, Montgomery arithmetic, congruence, Chinese remainder theorem, orders and primitive roots, quadratic residues, integer and modular square roots, prime number theorem, continued fractions and rational approximations.

Representation of finite fields: Prime and extension fields, representation of extension fields, polynomial basis, primitive elements, normal basis, optimal normal basis, irreducible polynomials, Root-finding and factorization algorithm, Lenstra- Lenstra-Lovasz algorithm.

Elliptic curves: The elliptic curve group, elliptic curves over finite fields, Schoof's point counting algorithm.

Primality testing algorithms: Fermat Basic Tests, Miller–Rabin Test, AKS Test.

Integer factoring algorithms: Trial division, Pollard rho method, p-1 method, CFRAC method, quadratic sieve method, elliptic curve method.

Computing discrete logarithms over finite fields: Baby-step-giant-step method, Pollard rho method, Pohlig-Hellman method, index calculus methods, linear sieve method, Coppersmith's algorithm.

Quantum Computational Number Theory: Grover's algorithm, Shor's algorithm

Applications in Algebraic coding theory and cryptography.

Text Books/References:

1 Yan, Song Y. Computational Number Theory and Modern Cryptography. John Wiley & Sons, 2012.
2 Meijer, Alko R. Algebra for Cryptologists. Springer, 2016
3 Lidl, Rudolf, and Harald Niederreiter. Introduction to finite fields and their applications. Cambridge university press, 1994.
4 Apostol, Tom M. Introduction to analytic number theory. Springer Science & Business Media, 2013.

26CSC304 THEORY OF COMPUTATION 3 1 0 4

Course Description: This course provides an overview of the problems that can be solved by various kinds of abstract machines such as finite state machine, pushdown automata and Turing machine. It also deals with how efficiently problems can be solved on a model of computation, using an algorithm.

Course Outcomes: After successful completion of the course, students will be able to

1 Understand and apply the properties of formal languages
2 Illustrate grammar and grammar transformations for formal languages
3 Construct finite state machines
4 Apply stack data structures for automata
5 Design and develop computing devices such as Turing machines

Unit 1 Automata and Languages: Chomsky hierarchy of languages, Introduction Finite Automata - Regular Expressions - Nondeterministic Finite Automata - equivalence of NFAs and DFAs – Minimization of DFA.

Unit 2: Regular Expressions - Non-Regular Languages - Pumping Lemma for regular languages.

Unit 3: Parse tree derivations (top-down and bottom-up) Context free languages –Chomsky normal form, GNF - Push Down Automata - Pumping lemma for context free language. CYK Algorithm, Deterministic CFLs. Ambiguous grammar, removing ambiguity,

Unit4 :Computability Theory: Turing Machines - Non-deterministic Turing Machines –CSG, Undecidability - PCP Computation histories – Reducibility.

Suggested lab exercises:

The lab exercises are implementing using JFLAP (Java Formal Languages and Automata Package) is a visual simulation tool that makes abstract ToC concepts practical and interactive. It is especially useful for students who find automata theory highly mathematical.

Text books

1 Michael Sipzer, "Introduction to the Theory of Computation", Third Edition, Cengage Learning, 2012.

Reference Books

1 Martin and John, "Introduction to Languages and the Theory of Computation", New York, McGraw Hill, 2002.
2 Garey, Michael and Johnson D S, "Computers and Intractability: A Guide to the Theory of NP-
3 Completeness", New York, W.H. Freeman and Company, First Edition, 1979.
3 J E Hopcroft, R Motwani and J D. Ullman, "Introduction to Automata Theory, Languages, and Computation", Third Edition, Addison-Wesley, 2007.
4 Linz P, "An Introduction to Formal Languages and Automata", Fourth Edition, Narosa Publishing House, 2009

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								
CO2	2	2	2	2								
CO3	2	2	2	2								
CO4	2	2	2	2								
CO5	3	2	2	2								

26CSC304 Deep Learning 3 0 0 3

Course Outcomes (COs):

Course Outcomes	
CO1	To understand the theoretical foundations, algorithms, and methodologies of Neural Networks.

CO2	To design, implement, and evaluate deep learning models for real-world applications.
CO3	To analyze model performance and apply appropriate optimization and regularization techniques.
CO4	To explore modern deep learning architectures including CNNs, RNNs, Transformers, and Generative Models.
CO5	To explore sequence modlling algorithms are BPTT, LSTM, GRU and application in NLP.

Basics: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.
Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.
Deep Neural Networks: Difficulty of training deep neural networks, Greedy layerwise training. Better Training of Neural Networks: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Convolutional Neural Networks: LeNet, AlexNet.

Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs

Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

Recent trends: Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning.

Transformers: Transfer learning, data augmentation and hyperparameter search.

Applications: Vision, NLP, Speech (just an overview of different applications in 2-3 lectures)

Case Studies with Keras, MXNet, Deeplearning4j, Tensorflow, CNTK, or Theano.

Textbook:

1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

References:

1 Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT press 2016
2 Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
3 Pattern Recognition and Machine Learning, Christopher Bishop, 2007

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2					3	1
CO2	3	2	2	2	2	2					3	1
CO3	3	2	2	2	2	3					3	1
CO4	3	2	1	2	2	2					3	1
CO5	3	2	2	2	2	2					3	1

26CSC381 Deep Learning Lab 0 0 2 1

Course Outcomes (COs):

Course Outcomes	
CO1	To implement modern deep learning architectures including CNNs, RNNs, Transformers, and Generative Models.
CO2	To explore and implement the sequence modlling algorithms are BPTT, LSTM, GRU and application in NLP.

- Multilayer Perceptron, Gradient Descent, Backpropagation,
- Neural Networks.
- Convolutional Neural Networks: LeNet, AlexNet.
- Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units
- Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.
- Variational Auto encoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning.
- Transformers: Transfer learning, data augmentation and hyper parameter search.

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								3
CO2	2	2	2	3								3

SEMESTER 6

26MAT311 Graph Analytics and Algorithms 3 0 2 4

Course Description: This course provides an overview of graph theory and graph algorithms related to data science. Graph theory-based data analytics will be discussed in the course. The contents of this course will be useful to understand graph based deep learning models.

Course Outcomes: After successful completion of the course, students will be able to

1 Understand the basic definitions and properties of graph theory.
2 Understand and apply various graph algorithms for data science problems
3 Understand the concepts of matchings and related problems
4 Understand the concepts of planarity and graph coloring problems.
5 Understand and apply different graph centrality measures in graph networks.

Review of Graphs: Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, shortest path algorithm. Eccentricity.
Trees: Trees, cut-edges and cut-vertices, spanning trees, minimum spanning trees, DFS, BFS algorithms.

Connectivity: Graph connectivity, k-connected graphs and blocks.
Euler and Hamilton Graphs: Euler graphs, Euler's theorem. Hamilton cycles, Chinese-postman problem, approximate solutions of traveling salesman problem. Closest neighbour algorithm.

Matching and Colorings: Matchings, maximal matchings. Coverings and minimal coverings. Graph Dominations and Independent sets. Vertex colorings, Planar graphs. Euler theorem on planar graphs.

Large Scale networks: Introduction. Graph and Networks. Network topologies. Examples of large-scale networks and networked systems. Power Law distributions. Scale-free networks. Random graph models for large networks: Erdos-Renyi graphs, power-law graphs, small world graphs, phase transitions. Network stabilities.

Graph Networks and Centralities: Degree and distance centralities. Closeness centrality. Betweeness centrality. Eigenvector centrality and Page ranking algorithm and applications. Clustering coefficient and clustering centrality. Introduction to community detections.

Case Studies: Implementation of the centralities and community detection algorithms with Transport networks, Biological networks, ect.,

Text Books:
1 J.A. Bondy and U.S.R. Murty, Graph Theory and Applications, Springer, 2008.
2 Mohammed Zuhair Al-Taie, Seifedine Kadry, Python for Graph and Network Analysis, Springer, 2018.

References Books
1 Barabasi and Pasfai, Network Science, Cambride University press, 2016.

2 Meghanathan Natarajan, Centrality Metrics for Complext Networks Analysis, IGI publisher, 2018.
3 Networks: An Introduction, M. E. J. Newman, Oxford University Press, 2010.
4 Complex Graphs and Networks, F. Chung and L. Lu, American Mathematical Society, 2006
Graph Algorithms in Neo4j

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3								2
CO2	2	2	2	3								2
CO3	2	2	2	3								2
CO4	2	2	2	3								3
CO5	3	2	2	3								3

26MAT312 Regression Analysis 3 0 2 4

Simple Linear Regression: Linear Regression Model, Least Square Estimation of the Parameters, Hypothesis Testing on the Slope and Intercept, Interval Estimation in Simple Linear Regression, Prediction of New Observations and Coefficient of Determination. Estimation by Maximum Likelihood. Model with Random Regressor.

Multiple Linear Regression: Multiple Linear Regression Models, Estimation of the Model Parameters, Hypothesis testing in Multiple Linear Regression, Confidence Interval on the Regression and Prediction of New observations.

Model Adequacy Checking: Introduction, Residual Analysis, PRESS Statistic, Lack of fit of the Regression Model. Influential Observations, Leverage, Measure of Influence, Cook's D.

Polynomial Regression Models: Polynomial Models in one variable, Piecewise Polynomial Fitting-Splines, Polynomial Models in two or more variables,

Generalized Regression Models: Logistic Regression Models, Poisson Regression.

Regression Analysis of Time Series Data: Detecting Autocorrelation, The Durbin-Watson Test, Estimating the Parameters in Time Series Regression Models.

Case studies with different data sets.

Text Books/References:

1 Douglas C. Montgomery and Elizabeth A. Peck and G.Geoffrey Vining, Introduction to Linear Regression Analysis",3rd Edition ,John Wiley& Sons, Inc
2 Keith McNulty, Handbook of Regression Modeling in People Analytics with Examples in R and Python, CRC Press, 2021.
3 Michael H Kutner, Christopher J. Nachtsheim, John Neter, William Li, Applied Linear Statistical Models, 5th Edition, Mc-Graw Hill India, 2013.
4 Andrew Gelman, Jennifer Hill, Aki Vehtari, Regression and other Stories, Cambridge University Press, 2020.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2								1
CO2	2	2	2	2								2
CO3	2	2	2	2								1
CO4	2	2	2	2								2
CO5	3	2	2	2								2

26CSC312 Software Engineering 3 0 2 4

Course Description: This course provides a comprehensive introduction to the fundamental principles, methodologies, and tools required for engineering high-quality software systems. It covers the entire Software Development Life Cycle (SDLC) – from requirement analysis and design to implementation, testing, and maintenance with an emphasis on Agile methodologies, modelling, and professional ethics.

Course Outcomes: After successful completion of the course, students will be able to

1 Understand and apply software engineering principles to real-world problems

2 Develop software requirement specifications (SRS) and design documents

3 Gain knowledge on planning, scheduling and risk management

4 Understand the importance of software quality assurance and develop the ability to conduct testing

5 Understand Agile methodologies and work in project teams

Unit 1: Software process and lifecycle: Software Product, Software Processes, Study of different process models, Project Management Concepts, Planning and Scheduling, Team organization and people management. Software requirement engineering: Software requirements, extraction and specification, Feasibility Studies, Requirements Modeling, object-oriented analysis.

Unit 2: Design Concepts: Object oriented design, Architectural design. Component level Design, User Interface Design, Distributed Systems Architecture, Real Time Software Design, User Interface Design, Pattern Based Design.

Unit 3: Risk Management: Metrics and Measurement, Estimation for software projects, software configuration management, Maintenance and Reengineering.

Unit 4: Software Testing: Unit testing, integration testing, black box and white box testing, regression testing, performance testing, object-oriented testing. Verification and validation of Software: Software Inspections and Audit, Automated Analysis, Critical systems validation.

Unit 5: Software Quality Assurance, Quality Standards, Quality Planning and Control, Various Quality models. Overview of recent trends in Software Engineering, Security Engineering, Agile Methods, Service Oriented Software Engineering, Aspect Oriented Software Development.

Text Books:

1 Ian Sommerville (2016). Software Engineering (10th ed.). Pearson Education Limited.

2 Roger Pressman (2020). Software Engineering: A Practitioner's Approach (9th ed.) McGraw-Hill Publication.

References:

1 Rajib Mall (2018). Fundamentals of Software Engineering (5th ed.). PHI Learning.

2 Ivar Jacobson et al. (2006) Object-Oriented Software Engineering: A Use Case Driven Approach. Pearson India Education Services.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	3	3					3	
CO2	2	3	3	2	3	3					3	
CO3	2	3	3	2	3	3					3	
CO4	2	3	3	2	3	3					3	
CO5	2	3	3	2	3	3					3	

26CSC311 Artificial Intelligence 2 0 2 3

Course Outcomes:

CO1: Give the knowledge on the fundamental concepts of Artificial Intelligence and intelligent agents.

CO2: Describe uninformed and heuristic search strategies, and adversarial search methods used in game playing.

CO3: Understand the knowledge representation techniques and analyze reasoning mechanisms under certainty and uncertainty.
CO4: Gain the inference mechanisms in first-order logic and explain various machine learning approaches.
CO5: Understand the concepts, structure, working principles, and applications of expert systems.

CO–PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1							1		1
CO2	2	3	3	1		1					1	1
CO3	3	3	2	1								1
CO4	3	3	3	2	1	1					1	1
CO5	2	2	1		1	1		1	1	1		1

Unit I: Foundations of Artificial Intelligence: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

Unit II: Search Strategies: Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A* ,AO* Algorithms, Problem reduction, **Game Playing**: Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

Unit III: Knowledge Representation and Reasoning: Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and dempstershafer theory.

Unit IV: First order logic: Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, learning from observation Inductive learning, Decision trees, Explanation based learning, Statistical Learning methods, Reinforcement Learning.

UNIT V: Expert systems: - Introduction, basic concepts, structure of expert systems, the human element in expert systems how expert systems works, problem areas addressed by expert systems, expert systems success factors, types of expert systems, expert systems and the internet interacts web.

Text Book:

1 S. Russel and P. Norvig, “Artificial Intelligence – A Modern Approach”, Second Edition, Pearson Education.

References:

1 David Poole, Alan Mackworth, Randy Goebel,”Computational Intelligence: a logical approach”, Oxford University Press.

2 G. Luger, “Artificial Intelligence: Structures and Strategies for complex problem solving”, Fourth Edition, Pearson Education.

3 J. Nilsson, “Artificial Intelligence: A new Synthesis”, Elsevier Publishers.

26CSC313 Computer Networks 3 0 2 4

Course Outcomes:

1 Gain the knowledge of the basic computer network technology.

2 Gain the knowledge of the functions of each layer in the OSI and TCP/IP reference model.

3 Obtain the skills of sub netting and routing mechanisms.

4 Familiarity with the essential protocols of computer networks, and how they can be applied in network design and implementation.

Unit 1: Introduction & Network Models

Topics: Network hardware/software, OSI & TCP/IP models, ARPANET, Internet.

Unit 2: Physical & Data Link Layer

Topics: Transmission media, framing, error detection, simplex protocols, sliding window protocols.

Unit 3: Medium Access & Data Link Switching

Topics: ALOHA, CSMA, collision-free protocols, Wireless LANs, switching.

Unit 4: Network Layer

Topics: Routing algorithms, congestion control, QoS, internetworking.

Unit 5: Transport & Application Layer

Topics: TCP/UDP, DNS, SNMP, Email, HTTP, streaming audio and video.

Text Book:

1 James Kurose and Keith Ross, Computer Networking: A Top-Down Approach, 8th edition, Person Edition.

Reference Books:

1 S. Keshav, An Engineering Approach to Computer Networks-, 2nd Edition, Pearson Education.

2 Behrouz A. Forouzan, Data Communications and Networking –. Third Edition TMH.

3 Andrew S Tanenbaum, David. j. Wetherall, Computer Networks, 5th Edition. Pearson Education

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3								1
CO2	2	2	2	2								2
CO3	2	2	2	2								2
CO4	2	2	2	2								1
CO5	3	2	2	3								2

26MAT313 Data Governance, Ethics and Law 1 0 01

Course Outcomes	
CO1	To understand the importance of ethics as a data science student
CO2	To gain knowledge about various types of ethics

Unit 1: Data Governance (5)

Data gathering and tools for data gathering, Ethics in data collections and management, Data privacy and protections, Case Studies.

Unit 2: Ethics and Law (15)

Different Types of ethics - Internet ethics, financial ethics - personal ethics - research ethics - healthcare ethics - professional ethics - social media ethics - business ethics - industrial ethics - publication ethics

Reference Books:

1 Katherine O'Keefe, Daragh O Brien, Ethical Data and Information Management Concepts, Tools and Methods, Kogan Page publisher, 2018.
2 The Ethics of Biomedical Big Data, Springer, 2016.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3									2	2
CO2	2	3	2								2	1

26CSC382 Open Lab I: C Programming 1 0 2 2

Course Description

This course introduces the fundamentals of C programming through hands-on laboratory practice. Topics include the basic data types, operators, control structures, arrays, functions, pointers, structures, unions, file handling, and command line arguments. Each lab session reinforces classroom concepts by enabling students to develop, test, and debug structured and modular programs. By the end of the course, students gain practical experience in writing efficient C programs and handling real-world data using files and memory-optimized constructs.

Course Outcomes (COs) On completing this course, students will be able to:

CO1	Understand the basic data types, variables, operators, and formatted I/O functions in C programming.
CO2	Apply decision making and looping statements to control program flow and solve basic computational problems.
CO3	Develop programs using arrays, strings, and functions for data handling and reuse.
CO4	Analyze problems and design recursive solutions to represent grouped data using structures and unions.
CO5	Build file-handling programs to create, read, write, and modify records.

LIST OF PROGRAMS

1. Demonstrating variables and constants in C.
2. Working with different operators with Input / Output operations.
3. Decision making and looping statements.
4. Creation and manipulation of one-dimensional arrays.
5. Matrix operations using two-dimensional arrays.
6. String manipulation functions.
7. Demonstrate the concept of user-defined functions.
8. Solving a mathematical problem using recursion.
9. Demonstrate structures and arrays of structures.
10. Implementing the concept of unions.
11. File operations for creation, reading, writing, searching and modification of records.
12. Handling with command line arguments.

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3								2
CO2	2	2	2	3								2
CO3	2	2	2	3								2
CO4	2	2	2	3								3
CO5	3	2	2	3								3

SEMESTER 7

26CSC401	Large Language Models	3 0 2 4

Course Description

This course explores the world of Transformers and Large Language Models (LLMs). Students learn the evolution of NLP methods, the core components of the Transformer architecture, along with how they relate to LLMs as well as techniques to enhance model performance for real-world applications. Through a mix of theory and practical insights, this course will equip students with the knowledge to leverage LLMs effectively. This course is ideal for the students with a background in calculus, linear algebra, and basic machine learning concepts.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understandthe foundations of NLP and Transformer architectures, including attention mechanisms, positional embeddings, and encoder/decoder-based models such as BERT and its variants.
CO2: Analyse the architecture and operational principles of LLMs, including mixture-of-expert's models, context handling, prompting strategies, sampling methods, and reasoning techniques such as chain-of-thought and self-consistency.
CO3: Design and implement LLM training and adaptation strategies, including pretraining concepts, supervised fine-tuning, parameter-efficient tuning (LoRA), quantization, hardware optimization, and alignment methods such as RLHF and DPO.
CO4: Develop LLM-based systems incorporating reasoning, retrieval-augmented generation, agentic frameworks (ReAct, function calling), and evaluate their performance using modern evaluation techniques including LLM-as-a-judge and bias analysis.
CO5: Critically assess emerging advancem
ents beyond classical Transformer-based LLMs, including diffusion language models, vision transformers, multimodal LLMs, and scalable reasoning architectures.

Background on NLP and tasks: Tokenization – Embeddings -Word2vec - RNN, LSTM Attention mechanism- Transformer architecture - Attention approximation-MHA, MQA, GQA - Position embeddings (regular, learned) - Transformer-based architectures - BERT and its derivatives.

Large Language Models: Definition and architecture - Mixture of experts - Context length, temperature - Sampling strategies - Prompting, in-context learning - Chain of thought - Self-consistency.

LLM training: Pre training –Quantization **-** Hardware optimization -Supervised fine tuning (SFT) - Parameter-efficient fine tuning (LoRA)

LLM tuning: Preference tuning - RLHF over view -Reward modelling - RL approaches (PPO and variants) – DPO.

LLM reasoning: Reasoning models - RL for reasoning – GRPO – Scaling
Agentic LLMs: Retrieval-augmented generation - Advanced RAG techniques - Function calling – Agents – Re Act framework.

LLM evaluation: LLM-as-a-judge overview - Best practices and benefits - Biases and pitfalls. Beyond Transformer-based LLMs- Diffusion LLMs - Adapting Transformer architecture for image - Vision Transformer – multimodal LLMs.

Text Books

1 Afshine Amidi and Shervine Amidi, "Super Study Guide: Transformers & Large Language Models" First edition, United States, 2024.
2 Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025.

References

1 Denis Rothman, "Transformers for Natural Language Processing and Computer ", Packt Publishing, Birmingham, 2024.
2 ZhihanLyu, "Applications of Generative AI", Springer, Switzerland, 2024.
3 Daniel and Martin JH"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2009.
4 Ben Auffarth, "Generative AI with Lang Chain: Build large language model (LLM) apps with Python, Chat GPT and other LLMs", Packt Publishing, Birmingham, 2023.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1					1	1	2
CO2	1	2	3	2	2	3			1	1	1	2
CO3	1	2	3	3	2	3			1	1	2	3
CO4	1	2	3	3	3	3			1	1	2	3
CO5	1	2	3	3	3	3			1	1	2	3

26CSC402 Deep Learning for Natural Language Processing 3 0 2 4

Course Description: Natural language processing (NLP) or computational linguistics is one of the most important technologies of the information age. Applications of NLP are everywhere because people communicate almost everything in natural language: web search, advertising, emails, customer service, language translation, virtual agents, medical reports, politics, etc. In the

2010s, deep learning (or neural network) approaches obtained very high performance across many different NLP tasks, using single end-to-end neural models that did not require traditional, task-specific feature engineering. In the 2020s amazing further progress was made through the scaling of Large Language Models, such as Chat GPT. In this course, students will gain a thorough introduction to both the basics of Deep Learning for NLP and the latest cutting-edge research on Large Language Models (LLMs).

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understand themathematical and linguistic foundations of NLP, including regular expressions, finite state transducers, language modeling, neural language models, and probabilistic models such as Hidden Markov Models and Naive Bayes.
CO2: Analyse and implement syntactic parsing techniques using formal grammars, CKY algorithm, probabilistic context-free grammars (PCFG), and dependency parsing methods.
CO3: Apply semantic processing techniques including vector semantics, word sense disambiguation, sentiment analysis, information extraction, named entity recognition, semantic role labeling, and coreference resolution.
CO4: Develop NLP applications using neural sequence models (RNN, LSTM) for tasks such as text summarization, topic modeling, question answering, and discourse analysis.
CO5: Design natural language generation and machine translation systems, analyzing linguistic similarities and differences, and applying statistical and transfer-based translation approaches.

WORDS: Introduction - Mathematical Foundations Linguistic Essentials - Regular Expressions, Text Normalization, Edit Distance- Finite State Transducers

CLASSICAL NLP & SEQUENCE MODELING: Language Modeling with N-grams - Naive Bayes Classification and Sentiment - Neural Nets and Neural Language Models - Hidden Markov Models - Part-of-Speech Tagging.

SYNTAX: Formal Grammars of English - Syntactic Parsing Ambiguity CockeKasami Younger (CKY) algorithm-PCFG Inside and Outside probabilities - Dependency Grammar Transition based parsing-MST based Dependency parsing.

SEMANTICS: Vector Semantics - Semantics with Dense Vectors - Word Senses: WSD and WordNet - Lexicons for Sentiment and Affect Extraction - Representation of Sentence Meaning - Computational Semantics - Information Extraction Named Entity Recognition - Semantic Role Labeling and Argument Structure - Coreference Resolution and Entity Linking.

PRAGMATICS AND APPLICATIONS: Discourse Coherence Neural Sequence modeling: RNN, LSTM Text Summarization - Topic Modelling - Question Answering.

NATURAL LANGUAGE GENERATION: Architecture of NLG Systems- Generation Tasks and Representations Application of NLG. Machine Translation: Language similarities and differences - The transfer metaphor Direct Translation Statistical translation - Translation involving Indian Languages.

Text Books

1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing ", Prentice –hall, Inc., 2017.
2. Christopher D. Manning, Hinrich Schutze, "Foundations of Statistical Natural Language Processing", The MIT Press, 2018.

References

1 Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Synthesis Lectures on Human Language Technologies, April 2017.
2 Steven Bird, Ewan Klein, and Edward Loper, "Natural Language Processing with Python - Analyzing Text with the Natural Language Toolkit", O,Reilly. 2019
3 Li Deng and Yang Liu, "Deep Learning in Natural Language Processing", Springer, Germany. 2018.
Dipanjan Sarkar, "Text Analytics with Python - A Practitioner's Guide to Natural Language Processing, Apress, 2019
4 Jalaj Thanaki, "Python Natural Language Processing - Advanced machine learning and deep learning techniques for natural language processing, Packt Publisher, 2017.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1					1	1	2
CO2	1	2	3	2	2	3			1	1	1	2
CO3	1	2	3	3	2	3			1	1	2	3
CO4	1	2	3	3	3	3			1	1	2	3
CO5	1	2	3	3	3	3			1	1	2	3

26CSC403 Reinforcement Learning 3 0 2 4

Course Description: Reinforcement learning (RL) is a paradigm that aims to model the trial-and-error learning process that is needed in many problem situations where explicit instructive signals are not available. It has roots in operations research, behavioral psychology and AI. The goal of the course is to introduce the basic mathematical foundations of reinforcement learning, as well as highlight some of the recent directions of research.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understand the basic building blocks of reinforcement learning and its merits & limitations.

CO2: Apply the RL algorithms to solve Multi-Armed Bandit problem

CO3: Formulate your task as a Reinforcement Learning problem, and how to begin implementing a solution.

CO4: Relate Markov decision process with Dynamic Programming

CO5: Understand the space of RL algorithms (Temporal- Difference learning, Q-learning and Sarsa)

Unit 1: Introduction: Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example- Tic-Tac-Toe.

Unit 2: Multi-armed Bandits: A k-armed Bandit Problem, Action-value Methods, the 10-armed Testbed, Incremental Implementation, tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms.

Unit 3: Finite Markov Decision Processes: 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. Review of Markov process and Dynamic Programming.

Unit 4: Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD, Sarsa: On-policy TD Control, Q-learning: Policy TD Control. Expected Sarsa. Maximization Bias and Double Learning.Eligibility Traces, Functional Approximation, Fitted Q, DQN & Policy Gradient for Full RL and Hierarchical RL.

Text Books

1 Richard S. Sutton and Andrew G. Barto, Reinforcement Learning:An Introduction, second edition, MIT Press, 2019.

References:

1. Phil Winder, Reinforcement Learning, O'Reilly Media Publisher, 2020.
2 Sudharsan Ravichandiran, Hand-on Reinforcement Learning with Python, Packt Publications, 2018.
3. Sayon Dutta, Reinforcement Learning with Tensor Flow: A beginner's guide, Packt Publications, 2018.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2		1				1	1		1
CO2	2	2	2		2				2	2		2
CO3	2	2	2		2				2	2		2
CO4	2	2	2		2				2	2		2
CO5	3	2	2		2				2	2		2

26CSC404 Data Security 3 0 0 3

Course Description: This course provides a comprehensive understanding of data security principles across computing systems, networks, multimedia, and databases. It covers access control models, authentication mechanisms, malware threats and defense strategies, secure communication protocols, multimedia security techniques, and database protection mechanisms. The course emphasizes modern security architectures such as Zero Trust, federated identity management, blockchain security applications, and privacy-preserving techniques in data publishing and big data systems. Students will gain both theoretical foundations and practical insights into designing secure systems and mitigating contemporary cyber threats.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Describe and compare access control models, authentication mechanisms, federated identity systems, and authentication protocols used in modern computing environments.

CO2: Analyze different types of malware and evaluate protection mechanisms including firewalls, IDS/IPS, EDR, and Zero Trust architectures.

CO3: Apply secure communication protocols and security mechanisms (TLS, IPSec, PGP, WPA3, Blockchain) to protect networked systems and web applications.

CO4: Evaluate digital watermarking, steganography, and visual cryptography techniques for protecting multimedia data and ensuring authenticity.

CO5: Design security solutions for databases and big data systems addressing SQL injection, inference attacks, privacy preservation, and distributed system security (e.g., Spark).

UNIT I – Access Control and Authentication

Access control mechanisms in general computing systems; Access control models – DAC, MAC, RBAC, ABAC; Authentication and authorization mechanisms – Passwords (Single-factor vs Multi-factor Authentication), Biometrics, CAPTCHA; Single Sign-On (SSO); Federated identity management – OAuth 2.0, OpenID Connect; Authentication protocols – Kerberos, X.509 certificates, Public Key Infrastructure (PKI), FIDO2/WebAuthn (overview).

UNIT II – Malware and Protection Mechanisms

Introduction to malware; Types – Viruses, Worms, Trojans, Ransomware, Spyware, Rootkits, Polymorphic and Metamorphic malware; Advanced threats – Botnets, Fileless malware, APT (overview); Protection mechanisms – Antivirus, Endpoint Detection & Response (EDR), Firewalls (Packet filtering, Stateful, Next-Generation Firewalls), Intrusion Detection and Prevention Systems (IDS/IPS); Zero Trust Security (overview).

UNIT III – Networking and Internet Security

Networking basics and common vulnerabilities; Web security principles; Email security; Secure communication protocols – SSL, TLS (including TLS 1.3), HTTPS; Wireless security – WEP, WPA, WPA2, WPA3 (overview); Secure Electronic Transaction (SET); PGP and S/MIME; IP Sec (AH and ESP modes); Introduction to Block chain and its security applications.

UNIT IV – Multimedia and Data Hiding Security

Image processing basics; Digital watermarking – Robust and Fragile watermarking techniques; Steganography – Spatial and Transform domain techniques; Visual cryptography; Applications in copyright protection and authentication.

UNIT V – Database and Big Data Security

Database system basics; Database security issues and control mechanisms; Database watermarking; Statistical inference attacks; Private Information Retrieval (PIR); Privacy in data publishing – k-anonymity, l-diversity, t-closeness (overview); SQL Injection and countermeasures; Introduction to Spark security – Authentication, Authorization, Encryption in distributed systems.

Text Books:

1 Mark Stamp, Information Security: Principles and Practice, 3rd Edition, Wiley, 2021.

2 Behrouz A. Forouzan &Debdeep Mukhopadhyay, Cryptography and Network Security, 3rd Edition, Tata McGraw Hill Education, 2015.

References

1 William Stallings and Lawrie Brown, Computer Security: Principles and Practice, 5th Edition, Pearson, 2023.

2 Atul Kahate, Cryptography and Network Security, 4th Edition, McGraw Hill Education, 2019.

OWASP Foundation, OWASP Top 10 Web Application Security Risks: 2025 Edition, Open Web Application Security Project (OWASP).

3 NIST Special Publications (SP 800 Series), including SP 800-207 “Zero Trust Architecture,” National Institute of Standards and Technology (NIST).

4 R. Sarma Danturthi, Database and Application Security*:* A Practitioner’s Guide, Addison-Wesley Professional, 2024.

5 Frank Y. Shih, Digital Watermarking and Steganography: Fundamentals and Techniques, 2nd Edition, CRC Press (2017).
6 Antony Lewis, The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and Distributed Ledger Technology, 2nd Edition, 2021.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1	1		2		1		2
CO2	2	2	2		2	2		2			1	2
CO3	2	1	3		3	2		2			1	2
CO4	2	2	2		1	2		1			1	2
CO5	2	2	3		3	3		2	1		2	2

26CSC481 Open Lab II: Java Programming 1 0 2 1

Course Description

This course introduces the fundamentals of Java programming through hands-on and practical coding with object-oriented concepts. Topics cover variables, data types, operators, control structures, arrays, and object-oriented principles such as classes, objects, inheritance, polymorphism, encapsulation, and abstraction. Lab exercises focus on implementing object-oriented design, handling exceptions, GUI development using Swing, working with files, and Applet-based applications.

Course Outcomes (COs)

On completing this course, students will be able to:

CO1	Understand the structure of Java, control structures, and object-oriented programming concepts such as classes, objects, constructors, and static members.
CO2	Apply inheritance, method overriding, and interfaces to implement object-oriented design.
CO3	Handle runtime errors with exception handling and perform concurrent programming using threads.
CO4	Implement enumerations, file I/O, lambda expressions, and string manipulation methods in Java programs.
CO5	Build a Swing-based GUI application for managing records, creating structured and reusable programs.

LIST OF PROGRAMS

1 Introduction to Java programming environment.
2 Programs using variables, data types, operators, and control structure.
3 Implementing loops and conditional statements to solve basic problems.
4 Creating classes and objects in Java.
5 Exploring different types of constructors and static members.
6 Implementing different types of inheritance and method overriding.
7 Handling runtime errors using exception handling mechanisms.
8 Creating and executing threads for concurrent programming.
9 Reading and writing data using File I/O streams.
10 Implementing lambda expressions to simplify code.
11 Performing string manipulations using String and String Buffer.
12 Developing Applets to display graphics and shapes.
13 Building Swing-based GUI applications for managing records.
14 Testing database connectivity and manipulating records through GUI.

SEMESTER 8

26CSC411	Internet of Things	2 0 2 3

Course Description: The **Internet of Things (IoT)** course provides a foundational yet comprehensive overview of interconnected devices, emphasizing the seamless integration of sensors, microcontrollers, and communication networks. It elucidates core architectural paradigms, fundamental protocols, and introduces hands-on development using platforms such as Arduino and Raspberry Pi. The course further acquaints students with cloud integration, data visualization, and essential security considerations, enabling them to conceptualize and implement rudimentary yet impactful IoT-driven solutions for real-world applications.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain the fundamental concepts, characteristics, architecture, enabling technologies, and challenges of the Internet of Things (IoT).
CO2: Identify and interface various sensors and hardware platforms such as Arduino, Raspberry Pi, and NodeMCU for data acquisition in IoT systems.
CO3: Analyze and apply IoT communication protocols, including IPv4/IPv6, RPL, MQTT, and CoAP, for efficient device connectivity and data exchange.
CO4: Evaluate cloud and edge computing paradigms for IoT applications and implement

basic data analytics using IoT cloud platforms.

CO5: Design and develop IoT-based solutions for real-world applications such as smart cities, healthcare, agriculture, and transportation through case studies and projects.

Unit 1: Introduction to loT - loT definition - Characteristics - Things in loT – IoT Components - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels - A Case Study to realise the stack.

Unit 2: Sensors and Hardware for loT - Arduino Software (IDE) - Installation of Arduino Software (IDE) – LEDS – Sensors - Accelerometer, Proximity Sensor, Light, lR sensor, Soil Moisture, Gas Sensor, Temperature and Humidity Sensor, Water, Chemical Sensor, Motion Detection Sensor. Hardware Kits - Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors (Lab Component)

Unit 3: Protocols for loT - infrastructure protocol IPV4/V6|RPL), Identification (URLs), Transport (Wi-Fi, Li-Fi, BLE), Discovery, Data Protocols, Device Management Protocols. - A Case Study with MQTT/CoAP usage. (Lab Component)

Unit 4: Cloud and Data analytics - loT with cloud challenges - Selection of cloud for IoT applications - Fog computing for loT - Edge computing for loT - Cloud security aspects for loT applications - RFM for Data Analytics - Case study with AWS / AZURE / Adafruit / IBM Bluemix (Lab Component).

Unit 5: Case studies with architectural analysis: loT applications - Smart City - Smart Water - Smart Agriculture - Smart Energy - Smart Healthcare - Smart Transportation - Smart Retail - Smart waste management. (Lab Component - As a project)

Text and Reference Books

1 "lnternet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti (UniversitiesPress)

lnfosys Training E Materials.

2 "The Internet of Things: Enabling Technologies, Platforms, and Use Cases', by pethuruRajand Anupama C. Raman (CRC press)

3 Adrian McEwen, Designing the internet of Things, Wiley (B November 2Ot3), ISBN13:978-.11-L1,8430620,

4 NPTEL Reference:https://onlinecourses.nptel.ac.in/noc17_cs22/preview

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	1	1				1		1

CO2	2	1	3	2	2	3			2	1	1	1
CO3	2	2	3	3	2	2			1	1	2	1
CO4	2	2	2	3	3	3	1		1	1	2	2
CO5	2	2	3	3	3	2	2	1	3	2	3	2

26CSC412 Quantum Computing 3 0 2 4

Course Outcomes:

CO1: Understand the basics of quantum mechanics and quantum computing principles.
CO2: Understand Quantum circuits, Single Qubit Gates and Operations.
CO3: Understand and apply quantum algorithms such as Deutsch's Algorithm, Deutsch's-Jozsa Algorithm, Shor's Algorithm.
CO4: Understand the Quantum information processing and error correcting.

Unit I: Linear Algebra Revisits: Complex Numbers Versus Real Numbers, Vectors, Scalar Multiplication, Vector Addition, and Bases.
Introduction to Quantum Computing: Quantum Bits, Bloch Sphere Representation of a Qubit, Multiple Qubits.
Unit II: Introduction to Quantum Mechanics: The Postulates of Quantum Mechanics, EPR Paradox, Quantum Physics Essentials, Atoms, Elementary Particles, And Molecules, Hilbert Spaces, and Uncertainty.
Unit III: Quantum Circuits: Single Qubit Gates and Operations, Multiple Qubit Gates and Operations, Design and Simulation of Quantum Circuits.
Unit IV: Quantum Algorithms: Introduction to Quantum Algorithms, Deutsch's Algorithm, Deutsch's-Jozsa Algorithm, Shor's Algorithm, Grover's Algorithm and Generalizations, etc.
Unit V: Quantum Information Processing and Error Correction: Quantum Noise and Quantum Operations, Classical Noise and Markov Processes, Quantum Operations, Distance Measures for Quantum Information; Quantum

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	2						2
CO2	3	3	3	2	2	3						2
CO3	3	2	3	3	2	2						2
CO4	3	2	2	3	3	3						2

26CSC482 Open Lab III CAPSTONE PROJECT 0 0 2 1

To become an expert data scientist, you need practice and experience. By completing this capstone project, you will get an opportunity to apply the knowledge and skills in R data analysis that you

have gained throughout the series. This final project will test your skills in data visualization, probability, inference and modeling, data wrangling, data organization, regression, and machine learning.

Week 1: Orientation & Domain Finalization
Capstone expectations, evaluation criteria
Identification of problem domain (Cybersecurity, Healthcare, Finance, etc.)
Discussion of current research trends
Week 2: Problem Statement & Proposal Draft
Problem definition and objectives
Initial literature exploration using IEEE / Springer
Proposal submission (Title + Abstract + Methodology outline)
Week 3: Literature Review & Gap Analysis
Review of 5–10 research papers
Identification of research gaps
Finalization of methodology
Week 4: Dataset Identification & Acquisition
Dataset selection (e.g., public repositories, APIs)
Data understanding and structure analysis
Ethical considerations and data privacy
Week 5: Data Preprocessing
Data cleaning, missing value handling
Outlier detection and normalization
Feature engineering basics
Week 6: Exploratory Data Analysis (EDA)
Statistical summaries and visualization
Pattern identification
Correlation analysis
Week 7: Model Selection
Selection of suitable algorithms from Machine Learning / Deep Learning
Baseline model implementation
Week 8: Model Development – Phase I
Training initial models
Implementation using Scikit-learn
Week 9: Model Development – Phase II
Advanced modeling (ensemble / neural networks)
Use of TensorFlow or PyTorch
Week 10: Model Evaluation
Performance metrics:
Accuracy, Precision, Recall, F1-score
Confusion matrix and ROC analysis

Week 11: Optimization & Tuning
Hyperparameter tuning
Cross-validation
Model comparison and selection
Week 12: Deployment Planning
API design (Flask/FastAPI)
System architecture planning
Introduction to cloud deployment
Week 13: Visualization & Dashboard
Dashboard design using Power BI or Tableau
Result interpretation
Week 14: Documentation & Report Writing
Report preparation (IEEE format)
Code documentation and GitHub submission
Optional paper drafting
Week 15: Final Presentation & Viva
Project demonstration
PPT presentation
Viva voce and evaluation

Electives

MATHEMATICS STREAM

26MAT331	**Real Analysis**	**2 0 2 3**

Course Description: This course provides a rigorous study of the fundamental concepts of real analysis. It covers the completeness property of real numbers, sequences and series, limits of functions, and continuity. Emphasis is placed on theoretical foundations, convergence criteria, and applications of limit and continuity concepts.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Apply the completeness property of the real numbers to analyse sets and functions.

CO2: Examine convergence and divergence of sequences using limit theorems, monotone convergence, and the Cauchy criterion.

CO3: Analyse convergence of infinite series using standard tests such as Ratio, Root, Integral, Limit Comparison, and Raabe's tests.

CO4: Evaluate limits and continuity of functions, including uniform continuity and properties of monotone and inverse functions.

Unit 1

Sets and Functions: The Completeness Property of $\mathbb{R}$ – Applications of the Supremum Property – Further applications of the Supremum Property.

Sequences: Sequences and their Limits – Limit Theorems – Monotone Sequences – The Cauchy Criterion – Properly Divergent Sequences.

Unit 2

Series: Introduction to Series – Absolute Convergence – Tests for Absolute Convergence – Limit Comparison Test – Root Test – Ratio Test – Integral Test – Raabe's Test – Tests for Non-Absolute Convergence.

Unit 3

Limits of Functions: Limit Theorem – Some Extensions of the Limit Concept.

Continuous Functions: Continuous Functions – Continuous Functions on Intervals – Uniform Continuity – Monotone and Inverse Functions.

Text Books:

1 Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, Fourth Edition, 2011

References

1 W. J. Kaczor and M. T. Nowak, Problems in Mathematical Analysis I - Real Numbers, Sequences and Series; American Mathematical Society, 2000.

2 S. C. Malik and Savita Arora, Mathematical Analysis, New Age International Publishers, Seventh Edition, 2024.

3 H. L. Royden and P. M. Fitzpatrick,Real Analysis, Pearson Education, Fifth Edition.

S. Kumaresan and Ajit Kumar, A Basic Course in Real Analysis, CRC Press, First Edition, 2014.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	3	3									
CO5	3	3	3									

26MAT332 Advanced Algebra 2 0 2 3

Course Description: This course gives a knowledge on advanced algebraic structures such a polynomial ring, Euclidean ring, PID, UFD and Extension Fields, etc. Students will study gcd, irreducible polynomials, and their splitting Field.

Course Outcomes: After successful completion of the course, students will be able to

CO1	To find field of quotient of integral domain and GCD of elements over Euclidean Ring.
CO2	To study polynomial ring, Euclidean ring and PID. Also, to identify irreducible polynomials over various rings.
CO3	To study the Field extension and algebraic extensions of a Filed.
CO4	To identify roots and the splitting Field of a polynomial over a Field.

Affinity Map:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	3	2	3	1						2	1
CO2	1	3	2	3	1						2	1
CO3	1	3	2	3	1						2	1
CO4	1	3	2	3	1						2	1
CO5	1	3	2	3	1						2	1

SYLLABUS:

Revision: Groups, Rings and Fields.

Unit 1: Maximal Ideals, the Field of Quotients of an Integral Domain, Euclidean Rings, Principal Ideal, Unit Element, Greatest Common Divisor, Prime Elements, Unique Factorization Theorem. (Sec. 3.5 to 3.7)

Unit 2: The ring of Gaussian integers, Fermat's Theorem, Polynomial Rings – F[x], Degree of a Polynomial, The Division Algorithm, Principal Ideal Ring, Irreducible Polynomial, principal ideal ring. (Sec. 3.8 to 3.9)

Unit 3: Sub Fields, Field Extensions, Finite Extensions, Algebraic Extensions and Their

Properties. The Transcendence of ‘e’. (Sec. 5.1 to 5.2)

Unit 4: Roots of Polynomials, Remainder Theorem, Splitting Field and its Uniqueness, The concept of constructible numbers and its Applications, Distinct and Multiple Roots, Simple Extension of a Field. (Sec. 5.3, 5.4, 5.5).

Text Book:

1 I.N. Herstein, ‘Topics in Algebra’, Second Edition, John Wiley and Sons, 2000.

References:

1 Joseph A. Gallian, ‘Contemporary Abstract Algebra’, Cengage Learning, 2013.

2 Michael Artin, ‘Algebra’, Second Edition, PHI Learning, 2014.

3 David S Dummit and Richard M Foote. ‘Abstract Algebra’, Third Edition, John Wiley and Sons, 2017.

26MAT333 Transform Techniques 2 0 2 3

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understand the basic properties of Laplace trasform.

CO2: Apply the Laplace transform to solve the differential equations.

CO3: Understand the basics of Fourier seris and its transformation.

CO4: Apply the Fourier transform to solve the PDE.

Laplace Transform: Laplace Transforms, Inverse Transforms, Linearity, Shifting, Transforms of Derivatives and Integrals, Differential Equations, Unit Step Function, Second Shifting Theorem, Dirac’s Delta Function. Differentiation and Integration of Transforms. Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations.

Fourier Series: Fourier series, Half range Expansions, Parseval’s Identity, Fourier Integrals, Fourier integral theorem Sine and Cosine Integrals.

Fourier Transforms: Sine and CosineTransforms, Properties, Convolution theorem**.**

Partial Differential Equations: Basic Concepts Modeling; Vibrating String, Wave Equation, Separation of Variables, Use of Fourier Series, Heat Equation; Solution by Fourier Series.

TextBook:

1 Advanced Engineering Mathematics, EK reyszig, John Wiley and Sons, Tenth Edition, 2016.

Reference Books:

1 Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
2 Engineering Mathematics, Srimanta Paland Subodh cBhunia, Oxfordpress,2015.
3 Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	3	3									
CO5	3	3	3									

26MAT335 DIFFERENTIAL EQUATIONS 2 0 2 3

Course Outcomes: After successful completion of the course, students will be able to:

CO1: Understand and apply the first order differential equations to some problems

CO2: Understand the solutions of the higher order ODE with various methods.

CO3: Understand the formation of the first order PDE.

CO4: To learn the solutions of higher order PDE.

Unit 1: Review of differential equations (order, degree, linear, nonlinear, implicit and explicit form of solution, general solutions, particular solution, singular solution). Exactness, nonexact equations reduce to exact form.
Part I: 1.1-1.9, 2.12-2.22 (5 hours)
Equations solvable for $\frac{dy}{dx}$, y, x, equations in Clairaut's form, equations reducible to Clairaut's form.
Part I: 4.1-4.11 (4 hours)

Unit 2: Linear homogeneous differential equations with constant coefficients, Euler- Cauchy equation,Linear Nonhomogeneous DifferentialEquations: Wronskian, linear independence, Method of undetermined coefficients. Method of variation of parameters.
Part I: 5.1-5.5, 6.1-6.3, 1.12,1.13, 5.26-5.27, 7.1-7.5 (9 hours)

Unit 3: Conversion of nth order differential equation to n first order differential equations, homogeneous linear system with constant coefficients, fundamental matrices, complex eigen values, repeated eigenvalues. simultaneous linear differential equations with constant coefficients, simultaneous linear differential equations with variable coefficients,
Part I: 8.1-8.3, 2.1- 2.7(8 hours)

Review of partial differential equations (order, degree, linear, nonlinear).

Unit 4: Formation of equations by eliminating arbitrary constants and arbitrary functions. General, particular and complete integrals.Lagrange's linear equation, Charpit's method, Methods to solve the first order partial differential equations of the forms f(p,q) = 0, f(z,p,q) = 0, $f_1(x,p) = f_2(y,q)$ and Clairut's form z = px + qy + f(p,q) where $p = \frac{\partial z}{\partial x}$ and $q = \frac{\partial z}{\partial y}$.
Part III: 1.1 – 1.5, 2.3-2.12, 3.1-3.2, 3.7-3.8, 3.10-3.18 (13 hours)

Unit 5: Homogeneous linear partial differential equations with constant coefficient of higher order. Non-homogeneous linear partial differential equations of higher order, method of separation of variables.
Part III: 4.1-4.12 (13 hours)

Textbooks:
1 M.D. Raisinghania, Ordinary and Partial Differential Equations, S.Chand, 18th edition, 2016.

References:
1 William E. Boyce and Richard C.DiPrima, Elementary differential equations and boundary value problems, Wiley india, 9th edition, 2012.
2 Nita H, Shah, Ordinary and Partial Differential Equations: Theory and Applications, PHI learning, 2nd edition, 2015.
3 Dennis Zill, A First Course in Differential Equations, Cengage Learning, 9th edition, 2009.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	3	3									
CO5	3	3	3									

26MAT336 Random Processes for Data Science 2 0 2 3

Course description: This course introduces the fundamentals of random processes, including their classification, statistical properties, stationary processes (SSS/WSS), autocorrelation, and key models such as Poisson and Gaussian processes. It also covers ergodicity, spectral analysis using power spectral density and the Wiener–Khinchin theorem, and Markov processes with the Chapman–Kolmogorov theorem, focusing on problem-solving and data science applications.

Course Outcomes: After successful completion of the course, students will be able to:
CO1: To gain knowledge about the basics of random process concepts and properties
CO2: To learn the application of random processes in terms of statistical distributions
CO3: To gain knowledge about the concepts of spectrum estimation and power spectral density
CO4: To learn Markovian property and Markov chains and their applications

Unit 1: Random Processes – introduction, Classification – statistical properties – examples Stationary processes – SSS/WSS processes, Examples on SSS/WSS processes Properties of autocorrelation function – problems, Examples on WSS/Variance.

Unit 2: Point process -Poisson process – concepts – properties Mean-autocorrelation of Poisson Process – proof Theorems on Poisson Process Problems on Poisson process Gaussian Process-First and Second Order Process Properties - Problems.

Unit 3: The spectrum estimation – concepts Mean ergodic theorem, Sufficient condition for Mean ergodicity - Problems Correlation Ergodicity Problems Power spectral density (PSD) – concepts-properties, Weiner Kinchine theorem Problems on PSD.

Unit 4: Markov Process – Chain – concepts, Chapman Kolmogorov theorem, steady state, Classification of states probabilities Problems on Markov chain.

Text Books:

1 A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.
2 J. Ravichandran, "Probability and Random Processes for Engineers", 1st Edition, IK International, 2015.

Books for Reference:

1 Sheldon M. Ross, "Stochastic Processes", 2ndEdition, Wiley, 1995.
2 J. Medhi, "Stochastic Processes", 2nd Edition, New Age International Private limited, 2006.
3 Roy D. Yates, David J. Goodman. (2005). Probability and Stochastic Processes, A Friendly Introduction for Electrical and Computer Engineers. John Wiley

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	1					2	3
CO2	3	3	3	2	3	1					3	3
CO3	3	3	3	2	3	1					2	3
CO4	3	3	3	2	2	1					3	2
CO5	3	3	2	2	3	1					2	3

26MAT337 Time Series Analysis 2 0 2 3

Course Description: This course introduces the fundamental concepts of time series analysis, including components, stationarity, autocorrelation, and methods for trend and seasonal decomposition. It covers modeling and forecasting using ARMA and ARIMA techniques, along with parameter estimation, diagnostics, and order selection. The course also includes seasonal models and advanced forecasting methods such as Holt-Winters and ARAR algorithms, with emphasis on practical applications in data analysis.

Course outcomes: After successful completion of the course, students will be able to:

CO1: Understand the fundamental concepts of time series, including components, stationarity, autocorrelation, and methods for trend and seasonal decomposition.
CO2: Apply ARMA models to analyze stationary time series and interpret ACF and PACF for modeling and forecasting.
CO3: Estimate and validate ARMA models using techniques such as maximum likelihood estimation, diagnostic checking, and order selection.
CO4: Analyze non-stationary time series using ARIMA and seasonal ARIMA models, including identification and forecasting methods.
CO5: Apply advanced forecasting techniques such as Holt-Winters and ARAR algorithms for real-world time series analysis.

Unit 1: Introduction: Examples of time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components.

Unit 2: Stationary Process and ARMA Models: Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA (p, q) processes, ACF and PACF, Forecasting of ARMA processes.

Unit 3: Modeling and Forecasting with ARMA Processes: Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection.

Unit 4: Nonstationary and Seasonal Time Series Models: ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors.

Unit 5: Forecasting Techniques: The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm. Estimation of time series models.

Textbooks:

1 Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.
2 Robert H. Shumway and David S. Stoffer Time Series Analysis and Its Applications with R Examples, Springer, 2016.

References:

1 Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
2 Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
3 Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
4 Avishek Pal and PKS Prakash, Practical Time Series Analysis, Birmingham - Mumbai, 2017.
5 Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-On Guide, 2nd Edition, Axelrod Schnall Publishers.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	2	3	1					3	3
CO2	3	2	3	2	2	1					2	3
CO3	3	3	3	2	3	1					3	3
CO4	3	2	3	2	2	1					3	2
CO5	3	3	3	2	3	1					3	2

26MAT338 WAVELETS 2 0 2 3

Course Outcomes	
CO1	Comprehend the basic properties of Discrete Fourier transform.
CO2	Analyze the construction of Wavelets on Z_n.
CO3	Analyze the construction of Wavelets on Z through $l^2(Z)$ and $L^2([-\pi,\pi))$.
CO4	Apply the concepts of Wavelets on R to construct Multiresolution Analysis.

The Discrete Fourier Transform: Basic Properties of the Discrete Fourier Transform, Translation-Invariant Linear Transformations, The Fast Fourier Transform.

Wavelets on Z_n: Construction of Wavelets on Z_n - The First Stage, Construction of Wavelets on Z_n - The Iteration Step, Examples and Applications.

Wavelets on Z: $l^2(Z)$, complete Orthonormal Sets in Hilbert Spaces, $L^2([-\pi,\pi))$ and Fourier Series, The Fourier Transform and Convolution on $l^2(Z)$, First-Stage Wavelets on Z, The Iteration Step for Wavelets on Z, Implementation and Examples.

Wavelets on R:$L^2(R)$and Approximate Identities, The Fourier Transform on R, Multiresolution Analysis and Wavelets, Construction of Multiresolution Analyses, Wavelets with Compact Support and their Computation.

Text Book:

1 Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer,1999.

References:

1 Daubechis, Ten Lectures on Wavelets, SIAM, 1992.

2 Mallat, S. A Wavelet Tour of Signal Processing, Elsevier, 2008

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2					1	1
CO2	3	3	2	2	2	2					1	1
CO3	3	3	2	2	3	2					1	1
CO4	3	2	2	2	2	2					1	1
CO5	2	1	2	1	2	1					1	1

26MAT340 Queuing Theory and Inventory Control Theory 2 0 2 3

Course Description: This course introduces the fundamental concepts and mathematical models of queueing systems and inventory management used in operations research and industrial engineering. It focuses on the analysis of stochastic models to optimize service systems and inventory policies under uncertainty.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Apply EOQ and other deterministic inventory models (with and without shortages) to minimize total inventory cost in multi-item systems.

CO2: Analyze inventory systems under uncertain demand using probabilistic EOQ and single-period models, including quantity discount policies.

CO3: Evaluate inventory models with backorders, lost sales, stochastic demand, and lead times using heuristic and exact approaches.

CO4: Analyze single and multi-server queueing systems using birth–death processes and compute steady-state performance measures.

CO5: Apply M/G/1 models and cost-based queueing decision techniques to determine optimal service policies under uncertainty.

Unit I : Deterministic Inventory Model

Types of inventories - Reason for carrying Inventory - Inventory Decisions - Costs Associated with Inventories – Factor Affecting Inventory Control - An Inventory Control Problem - The Concept of EOQ - Deterministic Inventory Model without shortages - Deterministic Inventory Model with shortages - Multi item deterministic problems.

Unit II: Probabilistic Inventory Model

Probabilitized EOQ Model - Probabilistic EOQ Model - Inventory Problem with Uncertainty Demand - Systems of Inventory Control - One Period Problem - One Period Problem without Set-up Cost - One Period Problem with set-up Cost, The Stochastic Process Associated with the Inventory System – Selection of an Operation Doctrine – Quantity discount "All Units Discount"

Unit III: Nature of the Inventory System

Heuristic Approximate Treatment for the Backorders Case - Heuristic Approximate Treatment for the Lost Sale Case – Computation of Time Average. Exact Formulae for the Backorders Case with Poisson Demand and Constant Procurement Lead Time - An Important Special Case - The Normal Approximation - An example involving the use of the exact form of Total Cost - The lost sales case for constant lead times - Stochastic lead times - Models with Q=1.

Unit IV: Queuing Systems

Elements of a Queuing Model, Role of Exponential Distribution, Pure Birth and Death Models (Relationship Between the Exponential and Poisson Distributions), Pure Birth Model, Pure Death Model, General Poisson Queuing Model, Specialized Poisson Queues, Steady-State Measures of Performance, Single-Server Models, Multiple-Server Models, Machine Servicing Model - (M/M/R): (GD/K/K), R<K

Unit V :Other Queuing Models

(M/G/1) :(GD/infinity/infinity) – Pollaczek - Khintchine (P-K) Formula, , Queuing Decision Models, Cost Models, Aspiration Level Model

Suggested lab exercises:

1 EOQ Model Implementation – Develop a program to compute EOQ, reorder level, and total inventory cost; perform sensitivity analysis.
2 EOQ with Shortages – Implement deterministic inventory model with shortages and compare total cost with no-shortage case.

3 Probabilistic Inventory Model – Simulate uncertain demand (Poisson/Normal) and compute safety stock and reorder point.
4 Single-Period (Newsvendor) Model – Determine optimal order quantity under uncertain demand with and without setup cost.
5 M/M/1 Queue Model – Compute and simulate performance measures such as utilization, average waiting time, and queue length.
6 M/M/c Queue Model – Analyze multi-server systems and study the effect of varying number of servers.
7 M/G/1 Queue Model – Apply Pollaczek–Khintchine formula and compare results with M/M/1 model.

Text Books

1 Hamdy A. Taha, "Operations Research an Introduction", 8th Edition, Prentice - Hall is an imprint of Pearson, 2008.
2 G.Hadley and T.M.Whitin, "Analysis of Inventory Systems" Prentice - Hall, Inc., Englewood Cliff.N.J. 1963.
3 Kleinrock, L. (1975). Queuing systems, volume 1: Theory.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	2	2	2									
CO3	2	2	2									
CO4	2	2	1									
CO5	3	2	1									

26MAT341 Theory of Sampling and Design of Experiments for Data Analysis 2 0 2 3

Course Description: This course introduces fundamental and advanced concepts of sampling techniques, including simple random, stratified, systematic, cluster, and resampling methods for efficient estimation. It covers properties of estimators, allocation methods, and acceptance sampling plans with performance measures. The course also focuses on principles of experimental design and analysis of variance for different classification models. Additionally, it provides practical knowledge of standard and factorial experimental designs used in statistical analysis.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Apply simple random, stratified, and systematic sampling techniques to estimate population mean, total, and proportion, and analyze properties of estimators.

CO2. Evaluate allocation methods and compare the precision of estimators under proportional and optimum allocation, including populations with linear trends.

CO3. Apply cluster, bootstrap, and jackknife sampling methods, and assess bias, variance, and performance measures of acceptance sampling plans (OC, AOQ, ASN, ATI).

CO4. Demonstrate principles of experimental design and perform analysis of variance (ANOVA) for one-way, two-way, and three-way classification models.

CO5. Apply standard designs (CRD, RBD, LSD, Graeco-Latin) and factorial experiments, including Yates procedure, confounding, and fractional factorial design for data analysis.

Unit 1: Simple random sampling, stratified random sampling, systematic random sampling - estimation of the population mean, total and proportion, properties of estimators, various methods of allocation of a sample, comparison of the precisions of estimators under proportional allocation, optimum allocation - Comparison of systematic sampling - Simple random sampling and stratified random sampling for a population with a linear trend.

Unit 2 : Cluster sampling – bootstrap sampling – jack knife sampling – bias and variance of estimates - Acceptance sampling for attributes, single sampling, double sampling, measuring performance of the sampling plans- OC, AOQ, ASN, ATI curves.

Unit 3 : Planning of experiments, Basic principles of experimental design, uniformity trails, analysis of variance, one-way, two-way and three-way classification models.

Unit 4 : Completely randomized design (CRD), randomized block design (RBD) Latin square design (LSD) and Graeco-Latin square designs.

Unit 5: Factorial experiments, 2^n and 3^n factorial experiments, analysis of 2^2 , 2^3 and 3^2 factorial experiments, Yates procedure, confounding in factorial experiments, fractional factorial design.

Text Books:

1 Cochran, W.C. Sampling Techniques, Third Edition, Wiley Eastern, (1977).

2 Murthy, M.N., Sampling Theory, Tata McGraw Hill, New Delhi, (1967).

3 Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

References:

1 Philip J. Ross, Taguchi's Techniques for quality Engineering, MaGraw-Hill, 1989.

2 Schilling E. G. (1982) Acceptance Sampling in Quality Control, Marcel Decker.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2							
CO2	2	3	2	3	2							

CO3	2	3	3	3	2							
CO4	2	3	3	3	2							
CO5	2	3	3	3	2							

26MAT342 Data Analytics in Computational Biology and Drug Designing 2 0 2 3

Course Outcomes

CO1: Apply pairwise and multiple sequence alignment to the biological databases.

CO2: Apply UPGMA and clustering methods for sequence alignment. Also gain knowledge in protein structure prediction

CO3: Understand the concept of quantitative structure and activity relationship and ADME properties related to drug metabolism

Unit-I : Introduction to Bioinformatics - applications of Bioinformatics - challenges and opportunities - introduction to NCBI data model- Various file formats for biological sequences. Bioinformatics resources – Importance of databases - Biological databases- Primary & Secondary databases. Sequence alignment methods- pairwise sequence alignment methods- Use of scoring matrices and gap penalties in sequence alignments- PAM and BLOSUM Scoring Matrices. Introduction to Dynamic Programming, Global alignments: Needleman Wunsch Algorithm, Local Alignments: Smith Waterman Algorithm, Gap Penalties. Multiple sequence alignment methods – Tools and application of multiple sequence alignment.

Unit-II: Sequence alignment tools, Phylogenetic analysis algorithms:Cladistic, and Phenetic methods- Clustering methods - Rooted and Unrooted tree representation Maximum Parsimony, UPGMA. Gene Prediction – methods and tools - similarity based and ab-initio prediction- Protein Domain analysis - Pfam, MOTIF search. Structure prediction methods: Chou-Fasman, GOR method, Neural Network, Threading and Fold recognition. Principles of protein folding. Types of interaction between atoms - Bond distance, Bond angle, Torsion Angle, Bond energy and Dipole-Dipole interactions. Methods to study protein folding - phi, psi & omega angles with distance. Zwitterion, Disulfide Bridge and Ramachandran Plot. Types of Helices, Beta turns, Gamma turns. FSSP, VAST and DALI.ProteinMis-folding and aggregation.

Unit-III: Introduction to pharmacogenomics, pharmacodynamics, pharmacokinetics and toxicogenomics. Process of drug development-clinical trials phases- Routes of drug administration - Biotransformation (Metabolism) of drugs and related organic compounds - Historical Development of QSAR, Tools and Techniques of QSAR, Molecular Structure Descriptors. Multivariate Statistical methods in QSAR, Important Drug Databases, General pathways, sites of

drug biotransformation, factors affecting drug metabolism and variability in drug response-ADME properties-physiological factors related to drug absorption and drug distribution. Designing Lipinski's Rule of Five, ADMET screening, Docking Studies.

References/ Textbooks

1 Higgins,Des and Taylor Williw: Bioinformatics: Sequence , Structure and databanks, Oxford , University Press,2000.
2 Baxenvants, AD., Bioinformatics: A practical guide to the analysis of genes and proteins", Third edition, John wiley& Sons ,2005
3 Teresa Attwood, Introduction ToBioinformatics,Pearson Education Singapore Pte Ltd, 2007
Mount, DW, Bioinformatics: Sequence and Genome analysis", Second edition, Cold Spring Harbor Laboratory Press. Baxevanis
4 A.D., Davison D.B., Page R. D. M. & Petsko G.A. Current Protocols in Bioinformatics. New York, John Wiley & Sons Inc., 2004.
5 S.C. Rastogi et al, Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) Kindle Edition.
6 Leach Andrew R., Valerie J. Gillet, An introduction to Chemoinformatics. Publisher: Kluwer academic, 2003. ISBN: 1402013477.
7 Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge, 2003. Publisher: Wiley-VCH. ISBN:3527306803.
8 Opera Tudor I,Ed. , Chemoinformatics in drug discovery, Wiley-VCH Verlag,2005.
9Kenneth M Merz, Jr, Dagmar Ringe, Charles H. Reynolds, Drug design: Structure and ligandbased approaches (2010) publisher: Cmabridge University press

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3					2	2
CO2	3	3	3	3	3	3					2	2
CO3	2	3	3	3	3	3					2	2

26MAT343 Statistical Quality Control 2 0 2 3

Course Description: This course provides a foundational understanding of Statistical Process Control (SPC) techniques used to monitor, control, and improve quality in processes and products. Emphasis is placed on Total Quality Management principles, statistical process control, control charts, process capability analysis, acceptance sampling, Six Sigma fundamentals, and Taguchi methods. The course enables students to apply statistical tools for quality improvement in manufacturing and service environments.

Course Outcomes: After successful completion of the course, students will be able to

CO1. Analyze and explain the principles of Total Quality Management and quality improvement philosophies.
CO2. Apply statistical process control techniques using control charts to monitor process performance.
CO3. Evaluate process capability and interpret advanced control charts for quality improvement.
CO4. Design and assess acceptance sampling plans using standard performance measures.
CO5. Design and optimize processes using Taguchi methods and Six Sigma concepts for robust product and process design.

Unit 1: Introduction to quality and quality control – Evolution of quality management (Inspection, Quality Control, Quality Assurance, Total Quality Management) – Japanese system of Total Quality Management – Quality Circles – Seven basic Quality Control tools –Plan-do-check-act (PDCA) cycle for project implementation.

Unit 2: Basic concept of quality control, process control and product control -Process and measurement system capability analysis - Area properties of Normal distribution. Statistical process control, theory of control charts, Shewhart control charts for variables-$\bar{x}$, R, s charts, attribute control charts - p, np, c, u charts, modified control charts, ARL of control charts.

Unit 3: Moving average control charts, EWMA charts, CUSUM charts – two sided and one-sided procedures – V – mask technique, process capability analysis, process capability indices, Metrics of Six Sigma, The DMAIC cycle - Overview of Design for Six Sigma - Lean Sigma – Statistical tools for Six Sigma.

Unit 4: Acceptance sampling for attributes, single sampling, double sampling, normal ang tightened inspection plans, measuring performance of the sampling plans- OC, AOQ, ASN, ATI curves**.**

Unit 5: Taguchi methods: Meaning of Quality, Taguchi's loss function, Introduction to orthogonal arrays – test strategies, steps in designing, conducting and analyzing an experiment, parameter and tolerance design: control and noise factors, signal to noise ratios, experimental design in Taguchi Methods with applications.

Suggested lab exercises:

The experiments may be performed using Excel / R / Python / Minitab or equivalent statistical software.

1 Control Charts for Variables: Construct $\bar{x}$ and R charts for a sample dataset.
Compute control limits and plot charts.
Identify out-of-control points and interpret causes.

2. Control Charts for Attributes: Construct p and c charts for defect data.
   Compute control limits and detect trends.
   Compare variable vs attribute control charts.
3. Process Capability Analysis: Evaluate process capability using Cp and Cpk.
   Analyze dataset for specification limits.
   Plot histogram and interpret process capability.
4. Acceptance Sampling: Apply single or double sampling plans.
   Compute OC, AOQ, ASN, and ATI curves.
   Compare efficiency of different sampling plans.
5. Taguchi Methods (Robust Design): Apply orthogonal array design for process optimization.
   Select 2–3 factors, compute S/N ratios.
   Identify optimal settings for minimal variation.

Text Books:

1 Montgomery Douglas C., Introduction to Statistical Quality Control, Sixth Edition. John Wiley & Sons, (2008).
2 Ishikawa K, Guide to Quality Control, 2nd Edition: Asian Productivity Organization, Tokyo (1983).
3 Ravichandran.J, Probability and Statistics for Engineers, 1st Edition 2012 (Reprint), Wiley India.
4 Harry, M and Schroeder, Six Sigma: The Breakthrough Management Strategy. Currency Publishers, USA. (2000)
5 Taguchi G, Introduction to Quality Engineering: Designing Quality into Products and Processes, Asian Productivity Organization, Second Edition. (1991).

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2						1	
CO2	3	2	2	3	3	2					1	
CO3	2	2	3	3	3	2					1	
CO4	3	3	3	3	3	2					1	
CO5	3	3	3	3	3	2					1	

26MAT344 SIX SIGMA ANALYTICS 2 0 2 3

Course Outcomes	
CO1	To understand the features of quality management practices
CO2	To gain knowledge about System standards and process mearurements
CO3	To apply various statistical tools and analytics of Six Sigma

Unit 1: Quality Management (7)

Introduction to Quality Management – Japanese System of Total Quality Management. Quality Circles - 7 Quality Control tools - 7 New Quality Control tools.

Unit 2: Measurement System (8)

ISO 9000 Quality system Standards - Project Planning, Process and measurement system capability analysis - Area properties of Normal distribution.

Unit 3: Statistical tools and Analytics of Six Sigma (15)

Metrics of Six sigma, The DMAIC cycle - Design for Six Sigma - Lean Sigma – Statistical tools for Six Sigma. Taguchi methods. Loss functions and orthogonal arrays and experiments.

Text books:

1 Ravichandran. J, Probability and Statistics for Engineers, 1st Edition 2012 (Reprint), Wiley India.

2 Ishikawa K., Guide to Quality Control, 2nd Edition: Asian Productivity Organization, Tokyo (1983).

3 Taguchi G, Introduction to Quality Engineering: Designing Quality into Products and Processes Second Edition. (1991).

Reference Books:

1 Montgomery Douglas C., Introduction to Statistical Quality Control, Sixth Edition. John Wiley & Sons, (2008).

2 Harry, M and Schroeder R., Six Sigma: The Breakthrough Management Strategy. Currency Publishers, USA. (2000).

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	2						2	1
CO2	3	3	3	3	2						2	1
CO3	3	3	3	3	2						2	1

26MAT345 Statistical Pattern Recognition 2 0 2 3

Course Outcomes	
CO1	To understand Bayesian decision theory and its use
CO2	To gain knowledge about Bayesian estimation methods
CO3	To apply nonparametric techniques and linear discriminant functions
CO4	To gain knowledge about nonmetric methods and algorithm independent machine learning
CO5	To apply unsupervised learning and clustering

Unit I : **(7)**

Introduction to Pattern Recognition, Introduction – Pattern recognition systems – the design cycle – learning and adaptation – Applications of Pattern recognition – statistical decision theory – Examples on pattern recognition, and image processing and analysis.

Unit II **(15)**

Parametric methods of Classification, Introduction – Bayes theorem and Bayesian decision making – classifications based on single and multiple features – conditionally independent features – discrete and continuous features - Gaussian case and general theory - discriminant functions, decision boundaries and decision regions — problems of dimensionality – components analysis and discriminants – Minimum error rate classification – Receiver Operating characteristic curves – Estimation of the composition of populations based on machine learning classification.

Unit III **(8)**

Nonparametric methods Classification, Introduction - histograms – density estimation –mixture densities - kernel and window estimators – nearest neighbor classification techniques – rules and distance metrics - single and k-nearest neighbor techniques –adaptive decision boundaries and discriminant functions – minimum squared error discriminant functions.

Unit IV **(7)**

Nonmetric methods of classification, Introduction to Nonmetric methods – decision trees and decision regions– CART methods – algorithm-independent machine learning – lack of inherent superiority of any classifier – bias and variance for regression and classification – resampling or estimating statistics – jackknife and bootstrap resampling methods.

Unit V **(8)**

Methods of Clustering, Introduction to unsupervised learning and clustering – data description and clustering – criterion functions for clustering – hierarchical clustering – single linkage algorithm, complete linkage algorithm, average linkage algorithm and Ward's algorithm – partitional

clustering – Forgy's algorithm - and k-means algorithm.

Text Books

1 Earl Gose, Richard Johnsonbaugh and Steve Jost, Pattern Recognition and Image Analysis, 2002, Prentice Hall of India.

References

1 Richard O. Duda, Peter E. Hart and David G. Stork, Pattern Classification, Second Edition, 2003, John Wily & Sons.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2						2	2
CO2		3	3	3	2						2	2
CO3		3	3	3	2						2	2
CO4		3	3	3	2						2	2
CO5		3	3	3	2						2	2

Computer Science Stream

26CSC331	Soft Computing	2 0 2 3

Course Outcomes	
CO1	Comprehend the search techniques of AI and soft computing.
CO2	Analyze the basics of Fuzzy logic and construction of fuzzy sets.
CO3	Analyze the importance of evolutionary computation and optimization.
CO4	Apply the genetic algorithm concepts to real life problems.
CO5	Design the Swarm intelligence algorithms and Hybrid algorithms.

Unit I: Artificial Intelligence: A Brief review, Pitfalls of Traditional AI. Search Algorithms: breadth first search, depth first search techniques, Hill Climbing, Best first Search, A* algorithm and AO* Algorithms. Soft computing: Introduction, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.

Unit II: Fuzzy Logic: Introduction – the case of imprecision, the utility and limitation of fuzzy systems. Classical sets and Fuzzy sets: operations, properties and mapping. Classical relations and fuzzy relations: cardinality, operations, properties and composition – tolerance and equivalence relations. Properties of membership function, fuzzification and defuzzification. Logic and fuzzy systems.

Unit III: Evolutionary Computation: Introduction, Historical Development of Evolutionary Computation, Features of Evolutionary Computation, Advantages and Applications of Evolutionary Computation, Conventional Optimization and Search Techniques.

Unit IV: Genetic Algorithms: Introduction, Biological Background, A simple genetic algorithm, Comparison of Genetic Algorithm with Other Optimization Techniques, Advantages, Limitations and Applications of Genetic Algorithm. Terminologies and Operators of GA: Encoding, Breeding, Search Termination, Fitness Scaling, Example problems.

Unit V: Swarm intelligence algorithms – Over view of Hybrid approaches (neural networks, fuzzy logics, genetic algorithm etc).

Text Books:

1 Ross T J 'Fuzzy Logic with Engineering Applications', TMH, 2002.
2 S.N.Sivanandam and S.N.Deepa, Introduction to Genetic Algorithms, Springer Berlin, Heidelberg, 2007.
3 Kumar S. 'Neural Networks – A classroom approach', TMH, 20014.
4 Eiben A E and Smith J E, 'Introduction to Evolutionary Computing', Second Edition, Springer, Natural Computing Series, 20017.

Reference Books:

1 Konar A, 'Computational Intelligence: Principles, Techniques and Applications", Springer Verlag, 2005.
2 Engelbercht AP, 'Fundamentals of Computational Swarm Intelligence', John Wiley and Sons, 2005.
3 Jang J S R and Sun C T,Mizutani E, 'Neuron – Fuzzy and Soft Computing' , PHI, 2002.
4 Rajasjekaran S and VijayalakshmiPai G A 'Neural Networks, Fuzzy Logic and Genetic Algorithm', PHI, 2003.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2					2	2
CO2	3	3	2	2	2	2					2	2
CO3	3	3	3	2	3	2					2	2
CO4	3	3	2	2	2	2					2	2
CO5	2	2	3	1	2	1					2	2

26CSC332 Cryptography 2 0 2 3

Stream Ciphers & Randomness: Cryptographically secure pseudorandom generators (CSPRNGs) Basic Security principles, Linear Feedback Shift Registers (LFSRs) and their cryptanalysis

Block Ciphers & Symmetric Encryption: Introduction to Pseudorandom Functions (PRFs) and Pseudorandom Permutations (PRPs),Adversarial Models (KOA, KPA, CPA, CCA), Advanced Encryption Standard (AES) – structure and security, Modes of operation: CBC mode, CTR mode, OFBmode, GCM (Galois/Counter Mode)

Message Integrity & Authentication:

Cryptographic hash functions: Security properties, SHA-2, SHA-3 (Keccak), SHAKE
Message Authentication Codes (MACs), Authenticated Encryption, Introduction to hash-based data structures, Password hashing
Authenticated Encryption (AEAD): AES-GCM

Public-Key Cryptography: Hardness assumptions: Integer factorization, Discrete logarithm problem (DLP), Diffie-Hellman key exchange, RSA, ElGamal encryption, Elliptic Curve Cryptography (ECC), Introduction to post-quantum encyption/KEM

Digital Signatures: Security notions and types of forgery, RSA signatures, ElGamal& DSA, Elliptic Curve Digital Signature Algorithm (ECDSA),

Introduction to Emerging & Advanced Topics: Post-quantum cryptography (standardization efforts), Fully homomorphic encryption (FHE), Secure Multi-Party Computation (MPC), Differential privacy, trusted execution environments (TEE), Cryptography in AI/ML security, Privacy-preserving technologies

Text Books / References:

1 J. Menezes, P. C. V. Oorschot and S. A. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.
2 J. Katz and Y. Lindell, Introduction to Modern Cryptography, Chapman & Hall/CRC, 2007.
Abhijit Das and Veni Madhavan C. E., Public-Key Cryptography: Theory and Practice, Pearson Education India, 2009.
3 Stinson, Douglas R. Cryptography: theory and practice. Chapman and Hall/CRC, 4ed, 2019.
4 Dan Boneh and Victor Shoup, A Graduate Course in Applied Cryptography, V4, 2017

CO	Course Outcomes
CO1	Understand foundational principles of modern cryptography
CO2	Analyze symmetric-key cryptographic constructions and their security
CO3	Evaluate encryption modes and authenticated encryption mechanisms
CO4	Explore cryptographic techniques for data integrity and authentication
CO5	Understand public-key cryptography and digital signature schemes

26CSC3333 Business Analytics 2 0 2 3

Course Outcomes:

CO1: Understand the concept of data warehouse architecture and data preprocessing

CO2: Gain knowledge in graphical visualization techniques, OLTP and OLAP

CO3: Apply and analyse the real time data using predictive analytics and prescriptive analytics

Unit –I: Introduction to Business Analytics: Definition and Scope of Business analytics. Importance of data-driven decision making. Overview of analytics tools and techniques. Ethical considerations in business analytics. Data collection methods and sources, Types of Data – Attributes and Measurement – Types of data sets – Data quality – Types of Digital Data. Data Warehouse Architecture, Data Warehouse technologies, Pre-processing techniques - Data cleaning and data quality assurance, Data integration and transformation techniques, Data governance and security.

Unit-II: Descriptive Analytics Datavisualisation using charts: histograms, bar charts, box plots, line graphs, scatter plots. etc; Data description: Measure of Central Tendency, Measure of Dispersion, Relationship between variables: Covariance, Correlation and coefficient of determination.

OLTP and OLAP OLTP – OLAP – Different OLAP Architectures – OLTP and OLAP – Data models for OLTP and OLAP – Role of OLAP Tools in BI Architecture. Business Intelligence – Business Intelligence defined – Evolution of BI and Role of DSS, EIS, MIS and Digital Dashboards – Need for BI – BI value chain – Introduction to Business Analytics. BI Definitions and Concepts – BI Component Framework – Need for BI – BI Users – Business Intelligence applications – BI roles and responsibilities.

Unit-III: Predictive Analytics Regression Analysis: Linear, logistic regression. Time Series Analysis: Forecasting methods (e.g. exponential smoothing). - Measures of Forecast Error - Trend Analysis - Time Series Models - Auto Regressive Model - Applications of Time Series Models. Advanced Forecasting Techniques: Ratio to Moving Average, Winter Method.

Prescriptive Analytics

Nonlinear optimization, Monte Carlo simulations, Decision trees, Bayesian networks and BIC, Cross- validation, Boot strap methods, Decision Support Systems (DSS) and their applications.

Text books / References:

1. Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, " Business Analytics Principles, Concepts, and Applications - What, Why, and How", Pearson Ed, 2014
2. Christian Albright S and Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", Fifth edition, Cengage Learning, 2015.
3. James R. Evans, "Business Analytics - Methods, Models and Decisions", Pearson Ed, 2012.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3					2	2
CO2	3	3	3	3	3	3					2	2
CO3	2	3	3	3	3	3					2	2

26CSC335 Predictive Analytics 2 0 2 3

Course Description: This course aims to equip students with skills to analyse historic data, build machine learning models (regression, classification, forecasting), and apply these to solve real-world business problems. Objectives focus on data pre-processing, model evaluation, and utilizing software tools to predict future outcomes.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Extract key information from the data by using data mining techniques

CO2: Fetch data from various sources and apply data pre-processing techniques

CO3: Choose appropriate model for data analysis

CO4: Evaluate and implement classification algorithms

CO5: Evaluate the accuracy and performance of different data mining models and algorithms

Unit 1: Introduction to Data Mining Introduction, what is Data Mining? Concepts of Data mining, Technologies Used, Data Mining Process, KDD Process Model, CRISP – DM, Mining on various kinds of data, Applications of Data Mining, Challenges of Data Mining.

Unit 2: Data Understanding and Preparation Introduction, Reading data from various sources, Data visualization, Distributions and summary statistics, Relationships among variables, Extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation, combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, Missing Values.

Unit 3: Model development & techniques Data Partitioning, Model selection, Model Development Techniques, Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine, Bayesian Networks, Linear Regression, Cox Regression, Association rules.

Unit 4: Model Evaluation and Deployment Introduction, Model Validation, Rule Induction Using CHAID, Automating Models for Categorical and Continuous targets, Comparing and Combining Models, Evaluation Charts for Model Comparison, Meta Level Modeling, Deploying Model, Assessing Model Performance, Updating a Model.

Text Books:

1 Eric Siegel. (2016) Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die. John Wiley & Sons, Hoboken, New Jersey.
2 Dean Abbott. (2014). Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst. Wiley.

References:

1 David L Olson (2016) Data Mining Models (2nd ed.), Business Expert Press.
2 Jeffrey T. Prince and Amarnath Bose. (2020) A Predictive Analytics for Business Strategy - Reasoning from Data to Actionable Knowledge, Mc Graw Hill.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	3	3					2	
CO2	2	3	3	2	3	3					2	
CO3	2	3	1	2	1	3					2	
CO4	2	3	3	2	3	3					2	
CO5	2	3	3	2	3	3					2	

26CSC336 Mining of Massive Datasets 2 0 2 3

Course Description

This course introduces the principles and techniques of data mining for large-scale and distributed data environments. It begins with foundational concepts, computational approaches, and statistical limitations inherent in extracting knowledge from massive datasets. The course explores distributed data processing frameworks such as MapReduce and Distributed File Systems, including algorithm design and extensions for scalable analytics. It further covers mining data streams using stream data models, sampling techniques, and filtering methods for real-time processing. Key data mining applications such as link analysis, frequent itemset mining, clustering, recommendation systems, web advertising, and social network graph mining are discussed. Advanced topics including dimensionality reduction and large-scale machine learning provide insights into handling high-dimensional and big data scenarios. The course equips students with theoretical understanding and practical strategies for scalable data mining in modern distributed systems.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain the fundamental principles of data mining, including computational approaches, statistical limitations, and challenges in large-scale data processing environments.

CO2: Design and implement distributed data processing solutions using MapReduce and Distributed File Systems, including the development of scalable algorithms and extensions for big data applications.

CO3: Apply stream mining techniques under the stream data model, including sampling, filtering, and real-time data processing methods.

CO4: Develop and evaluate data mining solutions for real-world applications such as link analysis, frequent itemset mining, clustering, recommendation systems, social network analysis, dimensionality reduction, and large-scale machine learning.

Basics of Data Mining - Computational Approaches - Statistical Limits on Data Mining - Bonferroni's Principle - MapReduce - Distributed File Systems. MapReduce. Algorithms Using MapReduce. Extensions to MapReduce. Finding Similar Items - Applications of Near Neighbor Search - Shingling of Documents - Similarity-Preserving Summaries of Sets - Locality-Sensitive Hashing for Documents - Distance Measures.

Mining Data Streams: The Stream Data Model - Sampling Data in a Stream - Filtering Streams. Link Analysis: PageRank - Efficient Computation of PageRank - Topic-Sensitive PageRank - Link Spam.

Frequent Itemsets: The Market-Basket Model - Market Baskets and the A-Priori Algorithm - Handling Larger Datasets in Main Memory.

Clustering: Introduction to Clustering Techniques - Hierarchical Clustering - K-means Algorithms – CURE algorithm. **Recommendation Systems:** A Model for Recommendation Systems - Content-Based Recommendations - Collaborative Filtering - Dimensionality Reduction.

Mining Social Network Graphs: Social Networks as Graphs - Clustering of Social-Network Graphs - Direct Discovery of Communities - Partitioning of Graphs - Finding Overlapping Communities – Simrank.

Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices- Principal-Component Analysis - Singular-Value Decomposition. Large-Scale Machine Learning - Machine-Learning Model - Perceptrons - Support-Vector Machines.

Text / References Book

1 Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.

2 Tom White, Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale O'Reilly Media; 4th edition, 2015.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	2	2					1	1
CO2	3	3	2	2	2	2					1	1
CO3	2	2	3	2	2	2					1	1

CO4	3	3	3	2	2	2					1	1

26CSC337 DATA COMPRESSION 2 0 2 3

Course Description: This course introduces the theoretical foundations and practical techniques of data compression for text, audio, image, and video signals. It begins with information theory concepts such as entropy, mutual information, and source coding theorems, and progresses to lossless and lossy compression techniques. The course covers classical coding schemes, quantization methods, transform-based image compression, audio coding standards, and modern video compression techniques. Students will gain analytical skills to evaluate compression performance and practical understanding of multimedia coding standards such as JPEG, JPEG-2000, MPEG, and H.261.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain entropy, mutual information, source coding theorem, and Kraft–McMillan inequality, and relate them to coding efficiency.

CO2: Apply text compression techniques such as Huffman coding (static/dynamic), Shannon-Fano-Elias coding, arithmetic coding, and dictionary-based coding.

CO3: Analyze scalar and vector quantization techniques and evaluate audio compression methods such as PCM, DPCM, ADPCM, and MPEG audio coding.

CO4: Evaluate transform-based and wavelet-based image compression methods including DCT, JPEG, JPEG-2000, JBIG II, GIF, and Haar transforms.

CO5: Analyze motion estimation and compensation algorithms and compare video compression standards such as H.261, MPEG-1, MPEG-2, MPEG-4, and MPEG-7.

UNIT I – Information Theory Foundations and Basics of Compression

Information Theory Foundations: Entropy and its properties; Conditional entropy; Mutual information; Types of codes; Kraft–McMillan Inequality theorem; Source coding theorem. Introduction to Compression Techniques: Need for compression; Types of compression – Lossy and Lossless; Performance measures (Compression ratio, Bit rate, Distortion); Modeling and Coding principles.

UNIT II – Lossless Text Compression Techniques

Text Compression Methods: Huffman Coding – Static and Dynamic; Applications in text compression; Shannon–Fano–Elias Coding; Arithmetic Coding; Dictionary-based Coding – Static and Adaptive methods; LZ family basics; UNIX Compress.

UNIT III – Quantization and Audio Compression

Scalar Quantization: Introduction; Uniform quantization; Adaptive quantization. Vector Quantization: Introduction; Advantages; LBG Algorithm; Tree-Structured Vector Quantization; Trellis-Coded Quantization. Audio Compression: Distortion criteria – Auditory perception; PCM, DPCM, ADPCM; Predictive coding – Basic algorithm; Basic Sub-band coding; MPEG Audio Coding.

UNIT IV – Image Compression

Distortion criteria – Human Visual System (HVS); Transform Coding – Discrete Cosine Transform (DCT); JPEG Standard; JBIG II; GIF Compression; Wavelet-based Compression – Wavelets, Scaling function, Haar Transform; JPEG-2000 Standard.

UNIT V – Video Compression

Motion Estimation and Compensation; Full Search and Fast Search Algorithms; Video Compression Standards – H.261; MPEG-1; MPEG-2; MPEG-4; MPEG-7; Overview of video coding framework and performance considerations.

Text Books:

1 Khalid Sayood, Introduction to Data Compression, 5th Edition, Morgan Kaufmann / Elsevier, 2018.

References

1 Iain E. G. Richardson, Video Codec Design: Developing Image and Video Compression Systems, Wiley, 2002.

2 David Salomon, Data Compression: The Complete Reference, 4th Edition, Springer, 2007.

3 Allen Gersho and Robert M. Gray, Vector Quantization and Signal Compression, Springer, 1992.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1					1	1	2
CO2	2	2	3	2	2	2			1	1	1	2
CO3	2	2	3	3	2	2			1	1	1	2
CO4	2	2	3	3	3	2			1	1	1	2
CO5	2	2	3	3	3	2			1	1	2	2

26CSC338 Introduction to Embedded Systems 2 0 2 3

Course Description: This course provides a foundational understanding of embedded systems with emphasis on 8051 and ARM architectures. Students learn microcontroller programming, interrupt handling, peripheral interfacing, and communication techniques. The course integrates theory with hands-on laboratory practice using modern development tools to design and debug basic real-time embedded applications

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain the fundamentals of embedded systems, microprocessors, microcontrollers, DSPs, and 8051 architectures.

CO2: Develop assembly and embedded C programs for 8051 using addressing modes, instruction sets, timers, interrupts, and serial communication.

CO3: Design and implement interfacing of peripherals such as LEDs, sensors, ADC, PWM, UART and communication modules.

CO4: Analyze ARM architecture including pipeline concepts, memory interface, AMBA bus and implement ARM assembly programs.

CO5: Develop and debug embedded system applications using Keil IDE and implement real-time interrupt-driven systems.

UNIT I – Embedded System Fundamentals and 8051 Architecture

Embedded systems overview, microprocessors, microcontrollers and DSPs. Computer architecture basics, Harvard and Von-Neumann models. 8051 architectures, block diagram, pin diagram, memory organization, registers, I/O ports and control signals.

UNIT II – 8051 Programming and Interfacing

Addressing modes and instruction set (data transfer, arithmetic, logical and control instructions). Timers, counters, interrupts and serial communication (RS232). Interfacing of LEDs, switches, sensors, ADC and PWM concepts.

UNIT III – ARM Architecture and Programming

RISC principles, ARM programmer's model and organization. Pipeline concepts (3-stage and 5-stage). ARM instruction execution, data processing, data transfer and control flow instructions. Thumb instruction set.

UNIT IV – Interrupts and Communication Interfaces

Interrupt structure of 8086 and ARM, vector interrupt table and ISR concepts. Synchronous and asynchronous data transfer. ARM memory interface, AMBA bus architecture and UART interfacing

UNIT V – Embedded Application Development

Peripheral modules: ADC, PWM, timers and UART. Embedded C basics. Application development, simulation and debugging using Keil IDE. Introduction to real-time embedded system design.

Text Books

1 The 8051 Microcontroller and Embedded Systems – M.A. Mazidi et al., Pearson, 2nd Edition, 2006.

2 ARM System-On-Chip Architecture – Steve Furber, Addison Wesley, 2nd Edition, 2000.

References:

1 Douglas Hall, Microprocessors and its Interfacing (SIE), McGraw Hill Education (India), 3rdEd., 2012.

2 Kenneth Ayala - The 8051 Microcontroller & Embedded Systems Using Assembly and C 1st Edition

Arnold S. Berger, "Embedded System Design", CMP Books, USA 2002.

3 Michael Barr, "Programming Embedded Systems with C and GNU‖, O Reilly, 2003.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1							1
CO2	3	3	2	1	3							1
CO3	3	3	3	2	3							1
CO4	3	3	2	2	3							1
CO5	2	3	3	2	3							2

26CSC339 INFORMATION RETRIEVAL 2 0 2 3

Course Description: This course introduces the fundamental principles and practical techniques used in modern Information Retrieval (IR) systems. It covers Boolean and ranked retrieval models, index construction techniques, compression strategies, vector space and probabilistic retrieval models, and evaluation methodologies. The course further explores web-scale search engine architecture, crawling mechanisms, and link analysis algorithms such as PageRank and HITS. Emphasis is given to both theoretical foundations and real-world search engine design considerations.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain the basic concepts of Information Retrieval, Boolean models, and indexing mechanisms.
CO2: Apply index construction techniques and compression methods for efficient retrieval.
CO3: Implement vector space and probabilistic retrieval models to compute document relevance.
CO4: Evaluate IR systems using standard performance metrics and benchmark datasets.
CO5: Analyze web search engine architecture, crawling mechanisms, and link analysis algorithms.

UNIT I – INTRODUCTION

Boolean retrieval – The Information Retrieval problem – Inverted index – Processing Boolean queries – Extended Boolean model – Ranked retrieval – Document delineation – Determining vocabulary of terms – Skip pointers – Search structures for dictionaries – Wildcard queries – Spelling correction – Phonetic correction.

UNIT II – INDEX CONSTRUCTION

Blocked Sort-Based Indexing (BSBI) – Single-Pass In-Memory Indexing (SPIMI) – Distributed indexing – Dynamic indexing – Statistical properties of terms in IR – Dictionary compression – Postings file compression.

UNIT III – VECTOR SPACE MODEL AND EVALUATION

Term frequency and weighting – TF-IDF – Vector space model – Queries as vectors – Computing vector scores – Cosine similarity – IR system evaluation – Standard text collections – Evaluation of unranked retrieval sets – Evaluation of ranked retrieval sets (Precision, Recall, F-measure, MAP, NDCG).

UNIT IV – PROBABILISTIC AND LANGUAGE MODELS

Probability Ranking Principle – Binary Independence Model – Appraisal of probabilistic models – Language models – Query likelihood models – Smoothing techniques – Merits and demerits of language models.

UNIT V – WEB SEARCH

Characteristics of the Web – Search user experience – Index size and estimation – Near-duplicates and shingling – Web crawler architecture – URL frontier – Link analysis – Web as a graph – PageRank algorithm – Hubs and Authorities (HITS algorithm).

Text Books:

1 Manning C, Raghavan P, Schutze H, "Introduction to Information Retrieval", Cambridge University Press, New Delhi, 2008.

2 Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", Addison Wesley, USA, 2011.

References:

1 Bruce Croft W, Metzler D, Strohman T, "Search Engines: Information Retrieval in Practice", Addison Wesley, USA, 2009.

2 Gerald K, "Information Retrieval Architecture and Algorithms", Springer, Heidelberg, 2013.

3 Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and 4 Evaluating Search Engines", MIT Press, Cambridge, USA, 2016.

5 Hang Li, "Learning to Rank for Information Retrieval and Natural Language Processing", 2nd Edition, Morgan & Claypool Publishers, USA, 2014.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										1
CO2	3	3	2	2	2							1
CO3	3	3	3	2	2							1
CO4	2	3	2	3	2							2
CO5	3	3	2	2	2	1						2

26CSC340 Social Network Analytics 2 0 2 3

Course Description: This course aims to equip students with the skills to model, analyse, and visualize complex networks (social, technological, or information) to uncover structural properties, identify influential nodes, detect communities, and understand information propagation or behavioural dynamics using data-driven methods.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understand the levels of SNA and network measures

CO2: Familiarize with network growth models

CO3: Gain knowledge about different community structures and link prediction models

CO4: Understand cascade behavior in networks

CO5: Predict and recommend in online social networks

Unit 1: Introduction: Applications, Preliminaries, Three Levels of SNA, Graph Visualization Tools.
Network Measures: Network Basics, Node Centrality, Assortativity, Transitive and Reciprocity, Similarity.

Unit 2: Network Growth Models: Properties of real-world networks, Random network model. Preferential Attachment model, Price's model – Local-world network growth model.

Unit 3: Link Analysis: Applications, Strong and weak ties – Link analysis and algorithms, Page Rank.

Community Structure in Networks: Applications, Types of Community detection methods, Disjoint community detection, overlapping community detection, local community detection.

Unit 4: Cascade Behavior and Network Effects: Cascade model – probabilistic cascade – Cascade prediction.

Anomaly Detection in Static Networks: Outlier vs Network-based anomalies, challenges in anomaly detection.

Unit 5: Graph Representation Learning: Machine Learning pipelines, Intuition behind representational learning – benefits – representational learning methods.

Case Study: Analysis of social network datasets, Modeling the spread of COVID 19, Recommendation System.

Text Books:

1 Tanmoy Chakraborty (2021) Social Network Analysis, Wiley.

References:

1 Albert-Lazzlo Barabasi (2016). Network Science, Cambridge University

2 Stanley Wasserman and Katherine Faust (1994). Social Network Analysis: Methods and Applications. Cambridge university press.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	2	2					2	
CO2	3	2	3	2	3	3					2	
CO3	3	3	2	2	2	3					2	
CO4	2	2	3	2	3	2					2	
CO5	3	3	3	3	3	3					2	

26CSC341 BIG DATA STORAGE AND ANALYSIS 2 0 2 3

Course Description: This course introduces scalable storage and processing architectures for Big Data systems. It covers batch, serving, and speed layers under the Lambda Architecture paradigm, along with Hadoop, Cassandra, MapReduce, Apache Storm, and distributed storage principles.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Explain the need for scalable distributed architectures and Lambda architecture principles.
CO2: Analyze and design batch processing systems using Hadoop and MapReduce.

CO3: Implement distributed storage solutions and apply partitioning strategies.
CO4: Evaluate serving layer and NoSQL databases such as Cassandra.
CO5: Design real-time stream processing systems using Apache Storm.

UNIT I – Big Data Foundations and Architectures
Scaling with Traditional Databases, Limitations of RDBMS, Need for NoSQL, First Principles of Distributed Systems, Desired Properties of Big Data Systems, Lambda Architecture Overview, Kappa Architecture, Data Lakes and Cloud Storage Concepts.

UNIT II – Distributed Storage Systems
Big Data Model and Properties, Fact-Based Modeling, Graph Schemas, Distributed File Systems, Partitioning and Replication Strategies, Hadoop Distributed File System (HDFS), Cloud Object Storage Concepts (Amazon S3 and Azure Data Lake), Cassandra Basics
.

UNIT III – Batch Processing Systems
Scalability Concepts, MapReduce Programming Model (Overview), Apache Spark Architecture, Spark Core and Spark SQL, Batch Layer Architecture, Design Overview and Workflow, Data Ingestion Techniques, Data Cleaning and Normalization.

UNIT IV – Serving Layer and Query Systems
Performance Metrics in Distributed Systems, Serving Layer Requirements and Design, Query Processing in Distributed Systems, Indexing Strategies, NoSQL Query Models, Distributed Data Access Patterns.

UNIT V – Real-Time and Stream Processing Systems
Real-Time Views, Kafka Architecture (Producers, Consumers, Topics), Stream Processing Concepts, Spark Structured Streaming, Windowing and Stateful Processing, Fault Tolerance and Scalability in Streaming Systems, Case Studies of Modern Data Pipelines.

Text Books:
1 Nathan Marz, James Warren, “Big Data: Principles and best practices of scalable real-time data systems”, Manning Publications 2015.

References
1 Kleppmann, M. (2017). Designing data-intensive applications. O’Reilly Media.
2 Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide. O’Reilly Media.
3 Carpenter, J., & Hewitt, E. (2016). Cassandra: The definitive guide: Distributed data at web scale (2nd ed.). O’Reilly Media.
4 Akidau, T., Chernyak, S., & Lax, R. (2018). Streaming systems. O’Reilly Media.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1					1	1	2
CO2	1	2	3	2	2	3			1	1	1	2
CO3	1	2	3	3	2	3			1	1	1	2
CO4	1	2	3	2	3	3			1	1	1	2
CO5	1	2	3	2	3	3			1	1	2	2

26CSC342 Full Stack Development 2 0 2 3

Course Description

This course provides a comprehensive introduction to modern full-stack web development using JavaScript and the MERN (MongoDB, Express.js, React, and Node.js) stack. It begins with core JavaScript concepts including objects, asynchronous programming, DOM manipulation, event handling, and browser APIs. The course then progresses to frontend development using React, covering component-based architecture, state management, routing, forms, and UI design. On the server side, students learn to build RESTful web applications using Node.js and Express, implement middleware and APIs, and manage data interactions. The course also introduces MongoDB for database design, CRUD operations, aggregation, indexing, and deployment strategies. Advanced topics such as modularization, server-side rendering, session handling, pagination, and integration of frontend and backend systems prepare students to design, develop, and deploy scalable, real-world MERN stack applications.

After successful completion of the course, students will be able to:

CO1: Demonstrate proficiency in JavaScript fundamentals, including objects, iteration mechanisms, DOM manipulation, event handling, asynchronous programming (event loop, micro tasks, macro tasks), and browser-based interactions.

CO2: Design and develop dynamic user interfaces using React, including component-based architecture, state management, event handling, forms, routing, styling, and component communication patterns.

CO3: Develop server-side applications using Node.js and Express, implementing RESTful APIs, middleware, routing, error handling, template engines, and testing strategies.

CO4: Design and manage MongoDB databases, including schema design, CRUD operations, indexing, aggregation, replication, sharding, and deployment strategies.

CO5: Build and deploy full-stack MERN applications integrating frontend, backend, and database layers, incorporating advanced features such as authentication/session handling, server-side rendering, modularization, pagination, and performance optimization.

JAVASCRIPT AND BASICS OF MERN STACK: JavaScript Fundamentals – Objects – Generators, advanced iteration – Modules – DOM tree – Node properties – browser events – Event delegation – UI Events – Forms, controls – Document and resource loading – Mutation observer – Event loop: microtasks and macrotasks – MERN Components – React – Node.js – Express – MongoDB – Need for MERN – Server-Less Hello World – Server Setup – nvm – Node.js – npm.

REACT: Introduction – React ES6 – React Render HTML – React JSX – Components – React Classes – Composing Components – Passing Data – Dynamic Composition – React state – setting State – Async State Initialization – Event Handling – Communicating from Child to Parent – Stateless Components – Designing components – React Forms – React CSS – React SaaS.

NODE.JS AND EXPRESS: Node.js basics – Local and Export Modules – Node Package Manager – Node.js web server – Node.js File system – Node inspector – Node.js Event Emitter – Frameworks for Node.js – Express.js Web App – Serving static resource – Node.js Data Access – Express REST APIs – REST – Resource Based – HTTP Methods as Actions – JSON – Express – Routing – Handler Function – Middleware – The List API – Automatic Server Restart – Testing – The Create API – Using the List API – Using the Create API – Error Handling – Template Engine.

MONGODB: Basics – Documents – Collections – Query Language – Installation – The mongo Shell – Schema Initialization – MongoDB Nodes – Driver – Reading from MongoDB – Writing to MongoDB – CRUD operations – projections – Indexing – Aggregation – Replication – – Creating backup – Deployment.

ADVANCED FEATURES: Modularization and Web pack – Routing with React Router – Forms – More Filters in the List API – UI Components – Update API – Delete API – React-Bootstrap – Bootstrap Installation – Navigation – Table and Panel – Forms – Alerts – Modals – Server Rendering – Basic Server Rendering – Handling State – MongoDB Aggregate – Pagination – Higher Order Components – Session Handling.

Text Books

1 Nader Dabit, Full Stack Serverless: Modern Application Development with React, AWS, and GraphQL, 2020, O'Reilly, First Edition.

2 Shama Hoque, Full-Stack React Projects: Learn MERN Stack Development, Packt Publishing Limited, 2020, First Edition.

References

1 Frank Zammetti, Modern Full-Stack Development: Using TypeScript, React, Node.js, and Express, First Edition.

2 Chris Northwood, The Full Stack Developer: Your essential guide to the everyday skills, Apress, 2018, First Edition.

3 Juha Hinkula, Hands-On Full Stack Development with Spring Boot 2 and React, Packt Publishing, 2019.

Jack Chan, Ray Chung, & Jack Huang, Python API Development Fundamentals, Packt Publishing, 2018.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1				1	1	1	2
CO2	1	2	3	2	2	3			1	1	1	2
CO3	1	2	3	2	2	2			1	1	2	2
CO4	1	2	3	2	3	2			1	1	2	2
CO5	1	2	3	2	3	2			1	1	2	2

22CSC343 CLOUD COMPUTING 2 0 2 3

Course Outcomes	
CO1	Understand the fundamental concepts of cloud computing, including service models, deployment models, and cloud architecture.
CO2	Apply cloud infrastructure and service models (IaaS, PaaS, SaaS) to design and manage cloud-based solutions.
CO3	Design and implement containerized and microservices-based applications using Docker.
CO4	Deploy, manage, and scale applications using Kubernetes in cloud environments.

Unit I

Introduction to Cloud Computing

Definition and evolution of cloud computing, Cloud service models: IaaS, PaaS, SaaS. Cloud deployment models: Public, Private, Hybrid, Community. Benefits and challenges of cloud computing.

Unit II

Cloud Infrastructure and Architecture

Cloud computing architecture, Virtualization concepts, Storage solutions, Cloud networking, Cloud security.

Unit III

Cloud Service Models in Detail

Infrastructure as a Service (IaaS): Concepts and components, Compute, storage, networking services, Security and identity services. Platform as a Service (PaaS): Application development platforms, Data management services, Middleware services, Integration and deployment. Software as a Service (SaaS): SaaS concepts and components, SaaS applications and delivery.

Unit IV

Cloud-Native Applications and Containerization

Cloud management and monitoring, Cloud orchestration and automation, Cloud resource management, Microservices architecture, Monolithic vs Microservices architecture, Designing and implementing Microservices.

Containerization: Containers and benefits, Docker: images, registries, runtimes, containerizing applications and dependency management, multi-container applications using Docker Compose.

Unit V

Container Orchestration and Kubernetes

Overview of container orchestration platforms: Kubernetes-Architecture, Components and core concepts, Deploying and managing applications, Service discovery, Scaling and load balancing, Rolling updates and fault tolerance. Alternative orchestration platform: Docker Swarm.

List of Hands-On Exercises

1 Create an account in a cloud platform and launch a virtual machine; configure basic storage and networking services.
2 Install Docker and execute basic commands to run, stop, and manage containers.
3 Create Docker images using Dockerfile and push images to a container registry.
4 Develop and deploy a multi-container application using Docker Compose.
5 Design and implement a simple microservices-based application and containerize the services.
6 Install and set up a Kubernetes cluster using Minikube.
7 Create and manage Pods, Deployments, and Services in Kubernetes.
8 Perform scaling, load balancing, and service exposure (ClusterIP/NodePort) in Kubernetes.
9 Implement rolling updates, rollback mechanisms, and monitor logs in Docker and Kubernetes environments.

Mini Project: Design and deploy a multi-tier cloud-native application using Docker and Kubernetes.

Text Books

1 Erl, T., Mahmood, Z., &Puttini, R. (2013). Cloud computing: Concepts, technology & architecture. Pearson.
2 Poulton, N. (2025). Docker deep dive (4th ed.). O'Reilly Media.
3 Burns, B., Beda, J., Hightower, K., & Evenson, L. (2022). Kubernetes: Up and running: Dive into the future of infrastructure (3rd ed.). O'Reilly Media.
4 Denniss, W. (2024). Kubernetes for developers. Manning Publications.

References

1. Bartlett, J. (2022). Cloud native applications with Docker and Kubernetes: Design and build cloud architecture and applications with micro services. A press.
2. Christudas, B. A. (2024). Java micro services and containers in the cloud: With Spring Boot, Kafka, PostgreSQL, Kubernetes, Helm, Terraform and AWS EKS. A press.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	1		1		1		1
CO2	3	2	3	2	2	2		1	1	1	1	1
CO3	2	2	3	2	2	3		1	2	1	1	1
CO4	2	2	3	3	3	3		1	2	1	2	2

26CSC344 Data Wrangling 2 0 2 3

Course Description: This course equips students with essential skills in data wrangling, analysis, and visualization using Python. Students will learn to handle diverse data formats, clean and prepare data, work with databases, and extract insights. The course also covers advanced topics like web scraping, PDF parsing, and automation, providing practical solutions to real-world data challenges.

Course Outcomes: After successful completion of the course, students will be able to

CO1: Teaches data wrangling, Python basics, and handling CSV, JSON, and XML for effective data analysis.

CO2: Learn to parse Excel and PDF files, convert formats, and understand relational, non-relational, and alternative data storage options for effective data management.

CO3: Learn to clean, format, normalize, and script data cleanup for accurate, standardized datasets.

CO4: Learn to import, analyze, visualize, and present data using charts, maps, and interactive tools.

CO5: Learn web scraping techniques using LXML, XPath, Selenium, and Scrapy for efficient data extraction and website crawling.

INTRODUCTION TO DATA WRANGLING: What Is Data Wrangling? - Importance of Data Wrangling -How is Data Wrangling performed? - Tasks of Data Wrangling-Data Wrangling

Tools-Introduction to Python-Python Basics-Data Meant to Be Read by Machines-CSV Data-JSON Data-XML Data.

WORKING WITH EXCEL FILES AND PDFS: Installing Python Packages-Parsing Excel Files-Parsing Excel Files -Getting Started with Parsing-PDFs and Problem Solving in Python-Programmatic Approaches to PDF Parsing-Converting PDF to Text-Parsing PDFs Using Pdf Miner-Acquiring and Storing Data-Databases: A Brief Introduction-Relational Databases: MySQL and PostgreSQL-Non-Relational Databases: NoSQL-When to Use a Simple File-Alternative Data Storage.

DATA CLEANUP: Why Clean Data? - Data Clean up Basics-Identifying Values for Data Clean Up-Formatting Data-Finding Outliers and Bad Data-Finding Duplicates-Fuzzy Matching-RegEx Matching-Normalizing and Standardizing the Data-Saving the Data-Determining Suitable Data Clean Up-Scripting the Cleanup-Testing with New Data

DATA EXPLORATION AND ANALYSIS: Exploring Data-Importing Data-Exploring Table Functions-Joining Numerous Datasets-Identifying Correlations-Identifying Outliers-Creating Groupings-Analyzing Data-Separating and Focusing the Data-Presenting Data-Visualizing the Data-Charts-Time-Related Data-Maps-Interactives-Words-Images, Video, and Illustrations-Presentation Tools-Publishing the Data-Open Source Platforms.

WEB SCRAPING: What to Scrape and How-Analyzing a Web Page-Network/Timeline-Interacting with JavaScript-In-Depth Analysis of a Page-Getting Pages-Reading a Web Page-Reading a Web Page with LXML-XPath-Advanced Web Scraping-Browser-Based Parsing-Screen Reading with Selenium-Screen Reading with Ghost. Py-Spidering the Web-Building a Spider with Scrapy-Crawling Whole Websites with Scrapy.

TEXT BOOKS

1. Jacqueline Kazil & Katharine Jarmul," Data Wrangling with Python", O'Reilly Media, Inc, 2016.

References:

1. Dr. Tirthajyoti Sarkar, Shubhadeep," Data Wrangling with Python: Creating actionable data from raw sources", Packt Publishing Ltd,2019.
2. Stefanie Molin," Hands-On Data Analysis with Pandas", Packt Publishing Ltd,2019
3. Allan Visochek," Practical Data Wrangling", Packt Publishing Ltd,2017.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3	3			1	1			3
CO2				3	3			1	1			3
CO3				3	3			1	1			3
CO4				3	3			1	1			3

CO5				3	3			1	1			3

26CSC345 Parallel and Distributed Systems 2 0 2 3

Course Description

This course provides a comprehensive study of parallel and distributed computing principles, architectures, programming models, and algorithmic foundations. It introduces processor architectures, types of parallelism, memory models, and classical taxonomies, followed by detailed exploration of shared and distributed memory systems, SIMD and vector processing architectures. Students learn parallel programming models, performance analysis techniques, and program design strategies including partitioning, synchronization, load balancing, and scalability analysis using Amdahl's and Gustafson's laws. The course covers theoretical models such as PRAM and BSP along with high-performance computing architectures including GPUs and accelerator-based systems. It also explores distributed computing paradigms, communication mechanisms, coordination algorithms, fault tolerance, and consistency protocols. The course equips students with both theoretical foundations and practical insights required for designing scalable high-performance and distributed systems.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts of parallel and distributed computing, including processor architectures, types of parallelism, memory models, and classical taxonomies.

CO2: Analyze shared, distributed, and hybrid parallel computer architectures, including SIMD, vector processors, GPGPU systems, and memory consistency models.

CO3: Design and evaluate parallel programs using appropriate programming models, applying partitioning, synchronization, load balancing, and performance optimization techniques.

CO4: Apply theoretical models such as PRAM and BSP to develop and analyze parallel algorithms using work-time formalism, Brent's theorem, and scalability principles.

CO5: Develop solutions for distributed systems by implementing communication protocols, synchronization mechanisms, leader election, consistency models, and fault-tolerant strategies.

INTRODUCTION: Concepts and Terminology – Generic Processor / ASIC Processor Architecture – Pipeline Architecture – Instruction Set Architecture –modification to the von

Neumann architecture - Types of Parallelism - Flynn's Classical Taxonomy –concurrent, parallel, distributed.

PARALLEL COMPUTER MEMORY ARCHITECTURES: Shared Memory - Distributed Memory -Hybrid Distributed-Shared Memory Multiprocessors: Communication and Memory issues - Message Passing Architectures –UMA – NUMA - Vector Processing and SIMD Architectures – Memory consistency models.

PARALLEL PROGRAMMING MODELS: Overview -Shared Memory Model - Threads Model - Message Passing Model - Data Parallel Model - Other Models. DESIGNING PARALLEL PROGRAMS: Automatic vs. Manual Parallelization - Understand the Problem and the Program - Partitioning -Communications - Synchronization -Data Dependencies - Load Balancing - Granularity -I/O -Limits and Costs of Parallel Programming - Performance Analysis and Tuning –speedup, efficiency – Amdahl's Lab – Gustafson's law – scalability – Parallel Examples -Array Processing - Compiler Transformation techniques for High performance computing: - Transformations for parallel Machines.

PRAM ALGORITHMS& BSP: PRAM model of computation- Work-Time formalism and Brent's Theorem; algorithm design techniques- parallel reduction, parallel prefix, pointer jumping, Euler tours, divide and conquer, symmetry breaking; survey of data-parallel algorithms; relative power of PRAM.

HIGH PERFORMANCE COMPUTING ARCHITECTURES: Latency Hiding Architectures -Multithreading Architectures -Dataflow Architectures - GPGPU Architecture- Overview of basic Accelerators /GPU / GPGPU and its programming model – CUDA - OpenCL. (6)

DISTRIBUTED COMPUTING: Introduction -Definitions, motivation – system models – architectural model – client-server model – peer-to-peer model – distributed computing paradigm - Communication Mechanisms - Communication protocols-RPC- RMI – group communication – external data representation and marshalling – distributed file system – HDFS - DISTRIBUTED PROGRAMMING ALGORITHMS: Fundamental issues & concepts - synchronization – termination detection – clocks – event ordering – locking – snapshots – leader election – replication and coherence – consistency models and protocols – Fault Tolerance

TEXT BOOKS

1. George Coulouris, Jean Dollimore, Time kindberg and Gordon Blair, "Distributed Systems: Concepts and design", Pearson, 2021 2.
2. Peter S Pacheco, Matthew Malensec, "An Introduction to Parallel Programming", Morgan Kaufmann (Elsevier), 2022 3.
3. John L. Hennessy and David A. Patterson, "Computer Architecture a Quantitative Approach", Elsevier, 2016.

REFERENCES

1. Andrew S. Tanenbaum and Maarten van Steen, “Distributed Systems, Principles and Paradigm”, Prentice Hall, 2017.
2. Michael J Quinn, “Parallel Computing: Theory and Practice”, Tata Mcgraw-Hill,2017.
3. Michael J Quinn, “Parallel Programming in C with MPI and OpenMP”, McGrawHill, 2017.
4. David F. Bacon, Susan L. Graham and Oliver J. Sharp, “Compiler Transformations for High Performance Computing”, Technical report, 1994.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1					1	1	2
CO2	1	2	3	2	2	3			1	1	1	2
CO3	1	2	3	3	2	3			1	1	2	3
CO4	1	2	3	3	3	3			1	1	2	3
CO5	1	2	3	3	3	3			1	1	2	3

26CSC346 High Performance Computing 2 0 2 3

Course Description: The HPC course objectives focus on enabling participants to understand parallel computing fundamentals, utilize high-performance cluster architectures, and develop proficiency in parallel programming (MPI, OpenMP) for scientific simulations. Courses aim to teach performance optimization, job scheduling, and efficient resource management for large-scale data processing

Course Outcomes: After successful completion of the course, students will be able to

CO1: Understand and apply various levels of parallelism including instruction, transaction, task,thread, memory, function, and data flow models.

CO2: Develop skills in parallel algorithm design and programming models to effectively utilize multi-core and cluster systems.

CO3: Learn techniques to measure and analyse performance of parallel algorithms

CO4: Analyse and compare scalable storage systems including RAID, SSD cache, SAS, and SAN.

CO5: Design and implement high-performance solutions for complex and large-scale computing

Unit 1: Introduction to HPC architectures: Shared and Distributed memory architectures, Multiprocessor Architecture. Parallel Processing Concepts, Levels and model of parallelism:

instruction, transaction, task, thread, memory, function, data flow models, demand-driven computation.

Unit 2: Parallel architectures: superscalar architectures, multi-core, multi-threaded, server and cloud; Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management.

Unit 3: Operating systems for scalable HPC, Parallel languages and programming environments, Open MP, Pthread, MPI, java, Cilk, Performance analysis of parallel algorithms, Fundamental limitations in HPC: bandwidth, latency, and latency hiding techniques.

Unit 4: Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA.

Unit 5: Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

Text Books:

1. George Hager, Gerhard Wellein – Introduction to High-Performance Computing for Scientists and Engineers, CRC Press, Taylor & Francis Group, 2019. Revised edition
2. Vipin Kumar, Ananth Grama, Anshul Gupta, George Karypis. Introduction to Parallel Computing (2nd ed.). Pearson India. 2003.
3. John L. Hennessy and David A. Patterson. Computer Architecture: A Quantitative Approach (5th ed.). Elsevier India Pvt. Ltd. 2011.

References:

1. David B. Kirk and Wen-mei W. Hwu. Programming Massively Parallel Processors: A Hands-On Approach (1st ed.). Elsevier India Pvt. Ltd. 2010.
2. Michael T. Heath. Scientific Computing: An Introductory Survey (2nd ed.). McGraw Hill Education (India) Private Limited, 2011

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	2	3	3					3	
CO2	3	2	3	2	3	3					3	
CO3	3	2	3	2	3	3					3	
CO4	3	2	3	2	3	3					3	
CO5	3	2	3	2	3	3					3	

26CSC347 Practical Techniques for Big Data Analytics 2 0 2 3

Course Objectives:

To provide students with a comprehensive understanding of Big Data concepts, technologies, and analytical frameworks, enabling them to store, process, manage, and analyze large-scale data using distributed computing platforms and modern data management tools.

Course Outcomes:

CO1: Familiarize the concepts of Big Data
CO2: Understanding the aspects of managing, cleaning and sampling of Data
CO3: Understanding Hadoop architecture and implement Map Reduce concept
CO4: Managing and querying No SQL databases
CO5: Understanding and executing HDFS using PIG and HIVE

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	2		1			2	2
CO2	2	2	2	2	2	2		2			2	2
CO3	2	2	2	2	2	2		1	2		2	2
CO4	2	2	1	2	2	2		1	2		1	2
CO5	1	2	1	1	1	2			3		1	2

Unit I: Introduction to Big Data: Types of Digital Data–Characteristics of Big Data – Evolution of Big Data – Definition of Big Data – Challenges with Big Data – 3Vs of Big Data. **Big Data Analytics:** Definition of big data analytics, Classification of analytics – Data Science – Terminologies in Big Data, Data science process – CAP and BASE Theorems.

Unit II: Hadoop: Introduction – Hadoop distributions, RDBMS VS HADOOP – Hadoop Components – Architecture – HDFS, HDFS daemons, Name node, data node, File read and write operations, HDFS Commands. Hadoop 2 (YARN): Architecture – Interacting with Hadoop Eco systems.

Unit III: MapReduce: Introduction – Mapper – Reducer – Combiner – Partitioner – Searching– Sorting Compression.

Unit IV: NoSQL: Types of Databases, SQL vs. NOSQL. No SQL databases: **Mongo DB:** Introduction – Features – Data types – Mongo DB Query language – CRUD operations – Functions: Count – Sort – Limit – Skip – Arrays– Aggregate. **Cassandra:** Introduction – Features

– Data types – CQLSH – Key spaces – CRUD operations – Collections – Counter – TTL – Alter commands

Unit V: Hive: Introduction – Architecture – data type – HQL (Database and Table Manipulation, DDL, DML, View, Joins), User defined functions. **Pig:** Features – Anatomy – Pig on Hadoop – Pig Philosophy – Pig Latin overview – Data types – Running pig – Execution modes of Pig – HDFS commands – Relational operators – Eval Functions – Complex data type – Piggy Bank – User defined Functions.

Text Books / Reference Books:

1. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publication, 2015.
2. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies", John Wiley & Sons, Inc., 2013.
3. Data Science and big data analytics: Discovering, analyzing, visualizing and presentation data, EMC Education Services, John Wiley 2015
4. Tom White, "Hadoop: The Definitive Guide", O'Reilly Publications, 2011.
5. Kyle Banker, "Mongo DB in Action", Manning Publications Company, 2012.
   Russell Bradberry, Eric Blow, "Practical Cassandra a Developers Approach ", Pearson Education.

26CSC348 Agentic Artificial Intelligence 2 0 2 3

Course Objectives:

To equip students with a comprehensive understanding of agentic AI principles, architectures, and design patterns, enabling them to design, develop, deploy, and monitor autonomous and multi-agent systems using modern frameworks and tools such as LangGraph, Agentic RAG, AutoGen, LlamaIndex, and observability platforms.

Course Outcomes:

CO1: Apply agentic AI principles to design autonomous and multi-agent systems using appropriate architectures and design patterns.
CO2: Apply LangGraph for state management, memory integration, and system deployment.
CO3: Apply Agentic RAG to build adaptive retrieval systems and compare with traditional RAG.
CO4: Apply Autogen and LangGraph to develop, deploy, and manage collaborative multi-agent workflows.
CO5: Apply observability tools to monitor, manage, and evaluate AI agent workflows and performance.

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2		1			1			1
CO2	2	2	2	1		3						1
CO3	3	3	3	2	2	2					1	1
CO4	2	2	3	2	1	3			3	1	2	1
CO5	2	2	2	1	2	3		2	1		2	3

Unit I: Introduction, Architectures and Design Patterns: Introduction to Agentic AI, Agent Structure and Architecture of multi-agent systems, Autonomous Agents, Human in the Loops Systems, Multi Agent AI Systems, Agentic AI Frameworks, Design Considerations and Best Practices. Modules: Perception, Cognitive, Action, Learning, Collaboration, Security, Design Patterns: Reflection, Tool Use, Planning, ReAct (Reasoning and Acting) and ReWOO (Reasoning with Open Ontology), Multi Agent

Unit II: Building AI Agents with LangGraph: Introduction to LangGraph, State Management, Trim and Filter Messages, Memory and External Memory, Short and Long Term Memory, Memory Schema, Deployment.

Unit III: Agentic RAG: Comparing Agentic RAG with Traditional RAG, Agentic RAG Architecture and Components, Adaptive RAG, Variants of Agentic RAG, Applications, Agentic RAG with LlamaIndex.

Unit IV: Agent Development with AutoGen: Autogen Introduction, Roles and Conversations, Conversation Patterns, Developing Autogen-powered Agents, Deployment and Monitoring Multi Agent Systems with LangGraph: Multi Agent Systems, Workflows, Collaboration, Multi Agent Designs, Workflow with LangGraph.

Unit V: Deploying AI Agent: AI Agent Observability and AgentOps, AI Observability with Langsmith, Monitoring AI Agent Performance, Managing AI Workflows, Implementing AI Experimentation and Observability.

TEXT BOOK:

1 Mastering AI Agents: From Design to Deployment of Autonomous Systems by Elbert Gale January 18, 2025, ISBN-13: 979-8307403822

REFERENCES:

1 Building AI Agent: Learn Building AI Agents, A Practical Guide for Building Intelligent Agentsby NatenapasFaraksa, March 2, 2024

2 Build Your Own AI Agent: A Hands-On Guide for Beginners by Sujai G Pillai, January 13, 2025, ISBN-13: 979-8306885971

26CSC349 Probabilistic Graphical Models 2 0 2 3

Course Outcomes:

CO	Course Outcome
CO1	Understand fundamentals of probability and graph theory for probabilistic models
CO2	Explain and analyse the structure and semantics of graphical models
CO3	Application of HMM, Kalman filters, and factor graphs
CO4	Apply and evaluate exact, approximate, and sampling-based inference techniques
CO5	Understand the parameter estimation and Apply and analyse structure learning techniques in graphical models

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2		1						1
CO2	2	2	2	1		3						1
CO3	3	3	3	2	2	2						1
CO4	2	2	3	2	1	3						1
CO5	2	2	2	1	2	3		2	1		2	3

Fundamentals: Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.

Graphical Models: Introduction - Directed Models (Bayesian Network), Undirected Models (Markov Random Fields), Dynamic Models (Hidden Markov Model & Kalman Filters) and Factor Graph; Conditional Independence (Bayes Ball Theorem and D-separation), Markov Blanket, Factorization (Hammersley-Clifford Theorem), Equivalence (I-Maps & Perfect Maps); Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.

Inference in graphical models: Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Junction Tree Algorithm; Belief Propagation (Sum Product); Approximate

Inference - Variational Methods (Mean Field, Kikuchi & Bethe Approximation), Expectation Propagation, Gaussian Belief Propagation; MAP Inference - Max-Product, Graph Cuts, Linear Programming Relaxations to MAP (Tree-Reweighted Belief Propagation, MPLP); Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs (Collapsing & Blocking), Particle filtering.

Learning in Graphical Models: Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudolikelihood, Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Structure Search, L1 priors.

Case studies.

Tools: SamIam and OpenGM

Text Books: 1. Koller, D. and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. MIT Press.

Reference Books:

1. Jensen, F. V. and Nielsen, T. D. (2002). Bayesian Networks and Decision Graphs. Information Science and Statistics. Springer, 2nd edition.
2. Kevin P. Murphy (2013) Machine Learning: A Probabilistic Perspective. 4th Printing. MIT Press.
3. Barber, D. (2011). Bayesian Reasoning and Machine Learning. Cambridge University Press, 1st edition.
4. Bishop, C. M. (2011). Pattern Recognition and Machine Learning (Information Science and Statistics). Springer, 2nd printing.
5. Wainwright, M. and Jordan, M. (2008). Graphical Models, Exponential Families, and Variational Inference. Foundations and Trends in Machine Learning, 1:1–305.

22CSC334 DEEP LEARNING FOR IMAGE PROCESSING 2 0 2 3

Course Outcomes (COs):

Course Outcomes	
CO1	To understand the theoretical foundations of Digital Image Fundamentals.
CO2	To understand the Fundamentals of Spatial Filtering.
CO3	To understand the Morphological Image Processing.

CO4	To explore modern deep learning architectures for visual data and data-driven image classification.

Mathematical Background for Image Processing: Review of Vectors and Matrices – Review of Probability and statistics. Digital Image Fundamentals: Elements of Visual Perception- Image Sensing and Acquisition – Image Sampling and Quantization – Basic Relationships between Pixels- Image interpolation. Intensity Transformations and Spatial Filtering: Basic Intensity transformation Functions – Histogram Processing – Fundamentals of Spatial Filtering – Smoothing and Sharpening Spatial Filters.

Filtering in Frequency Domain: 2D Discrete Fourier Transforms - Basics of filtering – Image Smoothing and Image Sharpening Using Frequency Domain Filters- Selective Filtering, Image Restoration: Noise Models – Restoration using Spatial Filters – Periodic Noise Reduction by Frequency Domain Filters.

Morphological Image Processing: Erosion – Dilation – Opening – Closing – Hit-or-Miss Transform- Extraction of Connected Components. Image Segmentation: Fundamentals – Point, Line and Edge Detection – Thresholding- Region Based Segmentation – Region Growing – Region Splitting and Merging. Color image processing.

Deep learning for visual data. Data-driven image classification, linear classification, activation functions, various cost functions, gradient-based optimization with backpropagation. Convolutional neural networks (CNN) and methods for training them, transfer learning and data augmentation. Different architectures and applications in image analysis (classification, detection, segmentation). Visualization and understanding of convolutional neural networks. Generative Adversarial Networks (GANs). Possibilities and limitations with deep learning.
Case Studies:

TEXT BOOK:

Gonzalez R C and Woods R E, "Digital Image Processing", Third Edition, Pearson Education, 2009.

REFERENCES:

1. *Pratt W K, "Digital Image Processing", Fourth Edition, John Wiley & Sons, 2007.*
2. *Castleman K R, "Digital Image Processing", Prentice Hall, 1996.*
3. *Gonzalez, Woods and Eddins, "Digital Image Processing Using MATLAB", Prentice Hall, 2004.*
4. *Russ J C, "The Image Processing Handbook", CRC Press, 2007.*

CO–PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2		1						2
CO2	2	2	2	1		3						2
CO3	3	3	3	2	2	2						2
CO4	3	3	3	2	1	3						3

26CSC350 Quantum Machine Learning 2 0 2 3

Course Objective

1. Understand the fundamental principles of quantum computing and its advantages over classical computing.
2. Explore the theoretical and practical aspects of quantum machine learning algorithms.
3. Develop the ability to implement quantum neural networks and variational quantum circuits.
4. Apply quantum techniques to real-world problems in image and signal processing.

Course Outcomes:

CO1: Demonstrate a solid understanding of quantum mechanics and quantum computing principles.
CO2: Implement quantum machine learning algorithms using quantum programming frameworks such as Qiskit and Pennylane.
CO3: Apply quantum feature extraction and classification techniques to complex datasets.
CO4: Utilize quantum computing techniques for image and signal processing tasks.

Unit I : Introduction to Quantum Computing: Classical vs. Quantum Computing, Qubits, Superposition, Entanglement, Quantum Gates, Quantum Measurement, Basic Quantum Algorithms.
Unit II: Fundamentals of Machine Learning: Supervised & Unsupervised Learning, Neural Networks, Optimization, Bias-Variance Tradeoff, Model Generalization
Unit III: Quantum Machine Learning: Quantum Data Encoding, Variational Quantum Circuits (VQCs), Quantum Kernel Methods, Quantum Neural Networks, Quantum GANs.
Unit IV: Quantum Image and Signal Processing: Quantum Image Representation, Quantum Fourier Transform, Quantum Edge Detection, Quantum Image Compression (8 Hours)
Unit V: Applications and Future Trends in Quantum Computing: Quantum Reinforcement Learning, Quantum Optimization, AI in Finance & Cryptography, Challenges & Future Research Directions.

Text books:

1. Nielsen, M. A., & Chuang, I. L., Quantum Computation and Quantum Information, Cambridge University Press

2 . Schuld, M., & Petruccione, F., Supervised Learning with Quantum Computers, Springer

Reference books:

1 . Jacob Biamonte, Peter Wittek, Nicola Pancotti, Patrick Rebentrost, Nathan Wiebe & Seth Lloyd, Quantum Machine Learning, Nature

2 . Carlo Ciliberto, Mark Herbster, Alessandro Davide Ialongo, Massimiliano Pontil, Andrea Rocchetto, Simone Severini and Leonard Wossnig, Quantum Machine Learning: A Classical Perspective, Royal Society

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	2						2
CO2	3	3	3	2	2	3						2
CO3	3	2	3	3	2	2						2
CO4	3	2	2	3	3	3						2