AMRITA VISHWA VIDYAPEETHAM
Integrated M.Sc Mathematics and Computing
Academic Year 2024 on wards

Vision: This Mathematics and Computing program is designed to cultivate leaders who will spearhead research, development, and innovation in cutting-edge disciplines and next-generation technologies, which demand extensive proficiency in Mathematics, Computer Science, Machine Learning, and Data Science.

Mission: The mission of the Integrated M.Sc. Mathematics and Computing course could be to equip students with a comprehensive understanding of both mathematical principles and computational techniques, fostering their ability to tackle complex real-world problems at the intersection of mathematics, computer science, and data analysis. Through rigorous academic training and practical experiences, the program aims to cultivate innovative thinkers and skilled professionals who can contribute effectively to research, development, and innovation in diverse fields such as artificial intelligence, cryptography, optimization, and scientific computing.

Program Outcomes

After completing the Integrated M.Sc., Mathematics and Computing course, the students will get proficiency in

S.No.	Program Outcomes
1	**Knowledge in Mathematics and Computer Science:** Understand the basic concepts, fundamental principles and the scientific theories related to Mathematics and Computer Science.
2	**Abstract thinking:** Ability to comprehend and grasp abstract concepts leading to various advanced theories in Mathematics, Statistics, and Computer Science.
3	**Modeling and Problem Solving:** Ability to model and solve problems by identifying and employing appropriate existing theories and methods.
4	**Advanced Theories and Methods:** Understand advanced theories and methods to design solutions for complex problems in Mathematics and Computer Science.
5	**Applications in Engineering and Sciences:** Recognize the role of mathematical sciences and apply them to solve real-life problems in various fields of Engineering and Science.
6	**Modern Software Tool Usage:** Acquire skills in handling scientific tools for problem-solving and solution analysis.
7	**Environment and Sustainability:** Understand the significance of preserving the environment for sustainable development.

8	**Ethics:** Embrace ethical, moral, and social values in personal and social life, leading to a highly cultured and civilized personality. Continuously enhance knowledge and skills in Mathematics and Computer Science for constructive activities, demonstrating the highest standards of professional ethics.
9	**Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and multidisciplinary settings.
10	**Communication:** Develop various communication skills such as reading, listening, and speaking to express ideas and views clearly and effectively.
11	**Project Management and Research:** Demonstrate knowledge and understanding of scientific and management principles, applying them to one's work as a member/leader in a team to manage projects and multidisciplinary research environments. Utilize research-based knowledge to analyze and solve advanced problems in Mathematics and Computing.
12	**Lifelong Learning:** Recognize the need for and possess the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
13	**Vertical Growth:** Students have the option to pursue higher studies either in mathematics or in computer-related subjects.

Integrated M. Sc. Mathematics and Computing

Curriculum (2024 on wards)

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
24MAT105	Calculus	3 1 0	4	24MAT115	Vector Calculus	3 1 0	4
24MAT106	Discrete Mathematics	3 1 0	4	24MAT116	Linear Algebra	3 0 2	4
24PHY103	Physics	3 0 0	3	24CSC111	Advanced Computer Programming	3 0 0	3
24CSC101	Problem Solving and Python Programming	3 0 0	3	24CSC112	Computer Architecture	3 0 2	4
24CSC181	Problem Solving and Python Programming Lab	0 0 2	1	24CSC182	Advanced Computer Programming Lab	0 0 2	1
24PHY183	Physics Lab	0 0 2	1	22ADM111	Glimpses of Glorious India	2 0 1	2
22ADM101	Foundations of Indian Heritage	2 0 1	2	22AVP103	Mastery Over Mind	1 0 2	2
	TOTAL		22		TOTAL		24
SEMESTER 3				**SEMESTER 4**			
24CSC201	Data Structures	3 0 0	3	24MAT214	Probability and Statistics with R	3 0 2	4
24MAT204	Algebra-I	3 1 0	4	24MAT215	Algebra-II	3 1 0	4
24MAT205	Computational Optimization	3 0 2	4	24MAT216	Analysis II	3 1 0	4
24MAT206	Analysis-I	3 1 0	4	24CSC211	Design and Analysis of Algorithms	3 0 0	3
24CSC202	Operating Systems	3 0 2	4	24CSC212	Database Management Systems	3 0 2	4
24CSC281	C Programming and Lab	1 0 2	2		Open Elective A*	3 0 0	3
24CSC282	Data Structures Lab	0 0 2	1	24CSC283	Algorithm Lab	0 0 2	1
23LSK201	Life Skills I	1 0 2	2		Amrita Value Programme II	1 0 0	1
	Amrita Value Programme I	1 0 0	1	23LSK211	Life Skills II	1 0 2	2
23ENV300	Environmental Science		P/F				
	TOTAL		25		TOTAL		26
SEMESTER 5				**SEMESTER 6**			
24MAT302	Complex Analysis	3 1 0	4	24CSC311	Computer Networks	3 0 2	4
24MAT303	Statistical Inference Theory	3 0 2	4	24CSC312	Machine Learning	3 1 0	4
24MAT304	Differential Equations	4 0 0	4	24CSC313	Data Mining and Warehousing	3 1 0	4
24CSC301	Evolutionary Computing	3 0 0	3	24MAT312	Numerical Computations	3 0 2	4
24CSC302	Theory of Computation	3 0 2	4	24MAT313	Transform Techniques	3 0 0	3
4MAT390@/ OEL	Live-in-Lab.@ / Open Elective B*	3 0 0	3	24CSC314	Internet of Things	1 0 2	2
23LSK301	Life Skills III	1 0 2	2	24CSC382	Data Mining Lab	0 0 2	1
24CSC381	Open Lab-I (JAVA Programming/C++ /etc.)	0 0 2	1	24CSC383	Machine Learning-Lab	0 0 2	1
				24CSC384	Open Lab II (Algorithms.io / Hadoop / Cascading / web design..,)	0 0 2	1
	TOTAL		25		TOTAL		24
				Exit Option with B.Sc Degree		**146**	
SEMESTER 7				**SEMESTER 8**			
24MAT501	Graph Analytics	3 0 2	4	24CSC511	Artificial Intelligence	3 0 2	4
24CSC501	Software Engineering	3 0 2	4	24CSC512	Parallel and Distributed Systems	3 0 2	4
24CSC502	Number Theory and Information Security	3 1 0	4	24CSC513	Data Security	3 0 0	3
24MAT502	Basic Topology	3 1 0	4	24CSC514	Reinforcement Learning	3 0 2	4
24CSC503	Deep Learning	3 0 2	4		Elective-III	3 0 0	3
	Elective-I	3 0 0	3		Elective-IV	3 0 0	3
	Elective-II	3 0 0	3		Elective-V	3 0 0	3
	Total		26		**Total**		24
				Exit Option with B.Sc Honors		**196**	
SEMESTER 9				**SEMESTER 10**			
	Elective-VI	3 0 0	3	24CSC699	Project II - Dissertation		12
	Elective-VII	3 0 0	3				
24CSC698	Project –I (Internship in Industries / Academic institutions)		8				
	Total		14		**Total**		12
					Total Credits		**222**

	Electives					Electives			
24MAT531	Advanced Algebra	3 0 0	3		24CSC531	Soft Computing	2 0 2	3	
24MAT532	Advanced Topology	3 0 0	3		24CSC532	Cryptography	2 0 2	3	
24MAT533	Functional Analysis	3 0 0	3		24CSC533	Business Analytics	2 0 2	3	
24MAT534	Operator Theory	3 0 0	3		24CSC534	Deep Learning for Image Processing	2 0 2	3	
24MAT535	Measure Theory	3 0 0	3		24CSC535	Predictive Analytics	2 0 2	3	
24MAT536	Theory of Ordinary Differential Equations	3 0 0	3		24CSC536	Mining of Massive Datasets	2 0 2	3	
24MAT537	Partial Differential Equations	3 0 0	3		24CSC537	Data Compression	2 0 2	3	
24MAT538	Commutative Algebra	3 0 0	3		24CSC538	Introduction to Embedded Systems	2 0 2	3	
24MAT539	Fixed Point Theory	3 0 0	3		24CSC539	Information retrieval	2 0 2	3	
24MAT540	Fluid Dynamics	3 0 0	3		24CSC540	Social Network Analytics	2 0 2	3	
24MAT541	Finite Element Methods	3 0 0	3		24CSC541	Big Data Storage and Analysis	2 0 2	3	
24MAT542	Advanced Graph Theory	3 0 0	3		24CSC542	Full Stack Development	2 0 2	3	
24MAT543	Representation Theory	3 0 0	3		24CSC543	Cloud Computing	2 0 2	3	
24MAT544	Coding Theory	3 0 0	3		24CSC544	Data Wrangling	2 0 2	3	
24MAT545	Statistical Pattern Recognition	3 0 0	3		24CSC545	Parallel and Distributed Systems	2 0 2	3	
24MAT546	Wavelets	3 0 0	3		24CSC546	High Performance Computing	2 0 2	3	
24MAT547	Statistical Quality Control	3 0 0	3		24CSC547	Advance Deep Learning	2 0 2	3	
24MAT548	Time Series Analysis	3 0 0	3		24CSC548	Advanced Big Data Analytics	2 0 2	3	
24MAT549	Computational Geometry	3 0 0	3		24CSC549	Computer Aided Drug Designing	2 0 2	3	
24MAT550	Queuing Theory and Inventory Control	3 0 0	3		24CSC550	Randomized Algorithms	2 0 2	3	
24MAT551	Nonlinear Dynamics and Chaos	3 0 0	3		24CSC551	Data Analytics in Computational Biology	2 0 2	3	
					24CSC552	Image Processing and Computer Vision	2 0 2	3	
					24CSC553	Multimedia Systems	2 0 2	3	

Elective courses can be taken from online courses, industry electives and other B.Tech / M.Tech/ M. Sc programmes.
@ code for live in Lab

LANGUAGES										
	Paper I					Paper II				
21HIN101	Hindi I	2 0 0	2	B	21HIN111	Hindi II	2 0 0	2	B	
21TAM101	Tamil I	2 0 0	2	B	21TAM111	Tamil II	2 0 0	2	B	
21KAN101	Kannada I	2 0 0	2	B	21KAN111	Kannada II	2 0 0	2	B	
21MAL101	Malayalam I	2 0 0	2	B	21MAL111	Malayalam II	2 0 0	2	B	
21SAN101	Sanskrit I	2 0 0	2	B	21SAN111	Sanskrit II	2 0 0	2	B	

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

Open Electives UG				
Course Code	Course Title	L – T – P	Cr.	ES
21OEL231	A Journey towards Free India	3 0 0	3	J
21OEL232	Political Leadership	3 0 0	3	J
21OEL233	Social issues in Contemporary India	3 0 0	3	J
21OEL234	The Story of Indian Business	3 0 0	3	J
21OEL235	Industrial Psychology	3 0 0	3	J
21OEL236	Advertising	3 0 0	3	J
21OEL237	Basic Statistics	3 0 0	3	J
21OEL238	Citizen Journalism	3 0 0	3	J
21OEL239	Creative Writing for Beginners	3 0 0	3	J
21OEL240	Desktop Support and Services	3 0 0	3	J
21OEL241	Development Journalism	3 0 0	3	J
21OEL242	Digital Photography	3 0 0	3	J
21OEL243	Emotional Intelligence	3 0 0	3	J
21OEL244	Essence of Spiritual Literature	3 0 0	3	J
21OEL245	Film Theory	3 0 0	3	J
21OEL246	Fundamentals of Network Administration	3 0 0	3	J
21OEL247	Gender Studies	3 0 0	3	J
21OEL248	Glimpses of Indian Economy and Polity	3 0 0	3	J
21OEL249	Graphics and Web-designing Tools	3 0 0	3	J
21OEL250	Green Marketing	3 0 0	3	J

21OEL251	Healthcare and Technology	3 0 0	3	J
21OEL252	History of English Literature	3 0 0	3	J
21OEL253	Indian Writing in English	3 0 0	3	J
21OEL254	Industrial Relations and Labour Welfare	3 0 0	3	J
21OEL255	Introduction to Ancient Indian Yogic and Vedic Wisdom	3 0 0	3	J
21OEL256	Introduction to Computer Hardware	3 0 0	3	J
21OEL257	Introduction to Event Management	3 0 0	3	J
21OEL258	Introduction to Media	3 0 0	3	J
21OEL259	Introduction to Right to Information Act	3 0 0	3	J
21OEL260	Introduction to Translation	3 0 0	3	J
21OEL261	Linguistic Abilities	3 0 0	3	J
21OEL262	Literary Criticism and Theory	3 0 0	3	J
21OEL263	Macro Economics	3 0 0	3	J
21OEL264	Managing Failure	3 0 0	3	J
21OEL265	Media Management	3 0 0	3	J
21OEL266	Micro Economics	3 0 0	3	J
21OEL267	Micro Finance, Small Group Management and Cooperatives	3 0 0	3	J
21OEL268	Negotiation and Counselling	3 0 0	3	J
21OEL269	New Literatures	3 0 0	3	J
21OEL270	Non-Profit Organization	3 0 0	3	J
21OEL271	Personal Effectiveness	3 0 0	3	J
21OEL272	Perspectives in Astrophysics and Cosmology	3 0 0	3	J
21OEL273	Principles of Marketing	3 0 0	3	J
21OEL274	Principles of Public Relations	3 0 0	3	J
21OEL275	Science, Society and Culture	3 0 0	3	J
21OEL276	Statistical Analysis	3 0 0	3	J
21OEL277	Teamwork and Collaboration	3 0 0	3	J
21OEL278	The Message of Bhagwad Gita	3 0 0	3	J
21OEL279	Understanding Travel and Tourism	3 0 0	3	J
21OEL280	Videography	3 0 0	3	J
21OEL281	Vistas of English Literature	3 0 0	3	J
21OEL282	Web-Designing Techniques	3 0 0	3	J
21OEL283	Organic Farming	3 0 0	3	J
21OEL284	Basic Legal Awareness on Protection of Women and Rights	3 0 0	3	J
21OEL285	Ritual Performances of Kerala	3 0 0	3	J
21OEL286	Documenting Social Issues	3 0 0	3	J
21OEL287	Fabrication of Advanced Solar Cell	3 0 0	3	J
21OEL288	Basic Concepts of X-ray Diffraction	3 0 0	3	J
21OEL289	Introduction to FORTRAN and GNUPLOT	3 0 0	3	J
21OEL290	Introduction to Porous Materials	3 0 0	3	J
21OEL291	Forensic Science	3 0 0	3	J
21OEL292	Introduction to solar Physics	3 0 0	3	J

21OEL293	Recycling Recovery and Treatment Methods for Wastes	3 0 0		3	J
21OEL294	Acting and Dramatic Presentation	2 0 2	3		J
21OEL295	Computerized Accounting	2 0 2	3		J
21OEL296	Kerala Mural Art and Painting	2 0 2	3		J
21OEL297	Painting	2 0 2	3		J
21OEL298	Reporting Rural Issues	3 0 0	3		J

Evaluation Pattern:

S.No	Course Type	Theory / Lab	Mid Term marks	CA marks	End Semester marks
1	3- 1- 0- 4 / 4- 0- 0 – 4 / 3- 0 – 3 - 3	Theory	30	20	50
2	3- 0- 2- 4 / 2- 0 2 – 3/ 1- 0- 2 -2	Theory & Lab	30	40	30
3	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
CO 1	Demonstrate competence in the mechanics of writing
CO 2	Summarise audio and written texts to convey messages effectively
CO 3	Apply mechanics of writing and AI tools to draft academic and professional documents
CO4	Organise ideas and thoughts for clear written and oral communication
CO 5	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 English Grammar,* CUP, 2004
2. Syamala, V. *Speak English in Four Easy Steps*, Improve English Foundation Trivandrum: 2006
3. Martinet, Thomson, *A Practical English Grammar*, IV Ed. OUP, 1986.
4. The Week - June 03, 2018, LAST WORD; https://www.theweek.in/columns/shashi-tharoor/2018/05/25/kindly-adjust-to-our-english.html?fbclid=IwAR3IhtdXqvuV4ySECn9S7SA6HmCEYISyd1QHd3BlwKgiNKKwdkeSg3qWp-U/
5. A G Gardiner – *Leaves in the Wind*, Digicat (e-book), 2015
6. Ruskin Bond – *The Best of Ruskin Bond*; India Penguin. April 2016.
7. Mrinal Pande – *Stepping Out*; Penguin India; 2003
8. W H Auden – *Another Time*; Random House Pub; 1940
9. William H Davies – *Songs of Joy and Others*; Andesite Press, August 2017.
10. Sir Ken Robinson – "Do schools kill creativity?". 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

21HIN101   **HINDI I**   **2 0 0 2**

Unit-1
a) Introduction to Hindi Language, -other Indian Language's, Official Language, link Language Technical terminology..
b) Hindi alphabet: ParibhashaAurBhed.
c) Shabda: ParibhashaAurBhed, RoopantharkiDrishti se
d) Sangya -ParibhashaAurBhed,SangyakeRoopanthar-ling, vachan, karak
e) Sarvanaam- ParibhashaAurBhed.

Unit-2

a) Common errors and error corrections in Parts of Speech –with emphasis on use of pronouns, Adjective and verb in different tenses –gender& number
b) Conversations, Interviews, Short speeches.

Unit -3
a) Letter writing –ParibhashaAurBhed, Avedanpatra (request letter) & Practice
b) Translation-ParibhashaAurBhed, English to Hindi

Unit- 4
Peom :
 a) Maithilisharangupth: sakhivemujsekahakarjaate
 b) Suryakanthtripatinirala :Priyatam
 c) Mahadevivarma- adhikaar
 d) Shiyaramsharangupth:ekphoolkichah

Unit- 5
Kahani
a) Kafan   - Premchand ,
b) Rajasthan ki Ek Gaav kee theerthyatra - Beeshmasahni
c) Raychandrabhai: By Mahathma Gandhi - Sathya ke prayog
d) Rajani - Mannu Bhandari

21KAN101   KANNADA I   2 0 0 2

   a) To enable the students to acquire basic skills in functional language.
   b) To develop independent reading skills and reading for appreciating literary works.
   c) To analyse language in context to gain an understanding of vocabulary, spelling, punctuation and speech

UNIT – 1

   a) Railway Nildanadalli – K. S. Narasimha Swamy
   b) Amma, Aachara Mattu Naanu – K. S. Nisar Ahamad
   c) Kerege Haara – Janapada
   d) Simhaavalokana – H.S. Shivaprakash

 UNIT – 2

   a) Mouni - Sethuram
   b) Meenakshi Maneya Mestru - Kuvempu
   c) Dhanwantri Chikitse - Kuvempu

 UNIT – 3

   a) Sukha –H.G Sannaguddayya
   b) Mobile Thenkara Jen Nonagala Jhenkara – Nagesh Hegade

c) Namma Yemmege Maatu Tiliyitu – Goruru Ramaswamy Iyangar

UNIT – 4
Language structure

a) Usage of punctuation marks
b) Introduction to words (right usage)
c) Reading skills
d) Sentence formation (simple & complex)
e) Translation- English to Kannada

References:

1. Kannada Samskruti Kosha – Dr. Chi. C Linganna
2. Kannada Sanna Kathegalu – G H Nayak
3. Lekhana Kale – N. Prahlad Rao
4. Kannada Sahithya Charithre – R. Sri Mugali

21MAL101   Malayalam I   2 0 0 2

Unit 1

Ancient poet trio:Adhyatmaramayanam,LakshmanaSwanthanam (Lines: valsasoumitre mungikidakayal),Ezhuthachan-Medieval period classic–Jnanappana(Lines:201 to 298),Poonthanam.

Unit 2

Modern Poet trio: EnteGurunathan, VallatholNarayanaMenon-Critical analysis of the poem.

Unit 3

Short stories from period 1/2/3:Poovanpazham-VaikaomMuhammedBasheer-Literary & Cultural figures of Kerala and about their literary contributions.

Unit 4

Literary Criticism: BharathaParyadanam-VyasanteChiri–Ithihasa studies-KuttikrishnaMararu-Outline of literary Criticism in Malayalam Literature-Introduction to KuttikrishnaMararu & his outlook towards literature &life.

Unit 5

Error-freeMalayalam: 1.Language; 2.Clarity of expression; 3.Punctuation-Thettillatha Malayalam – Writing-a. Expansion of ideas; b.PrecisWriting; c. Essay Writing; d.Letter

writing;.RadioSpeech;f.Script/Feature/Script Writing; NewsEditing; h.Advertising; i.Editing; j.Editorial Writing; k.Critical appreciation of literary works
      (Any one or two as an assignment).

21SAN101   **SANSKRIT I**   **2 0 0 2**

To familiarize students with Sanskrit language and literature.

To read and understand Sanskrit verses and sentences.

Self-study of Sanskrit texts and to practice communication in Sanskrit.

To help the students imbibe values of life and Indian traditions propounded by the scriptures.

To be able to speak in Sanskrit.

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.   (7 hours)

Module II
       Verbs- Singular, Dual and plural — First person, Second person, Third person. Tenses – Past, Present and future – Atmanepadi and parasmaipadi-karthariprayoga. (8hrs)

Module III
       Words for communication and moral stories. (4 hrs)

Module IV
       Chanakya Neethi first chapter (first 15 Shlokas) (6 hrs)

Module V
       Translation of simple sentences from Sanskrit to English and vice versa (5hrs)

24MAT105   **CALCULUS**   **3 1 0 4**

Differentiation: The Derivative as a Function – Differentiation Rules – The   Derivative as a Rate of Change – Derivatives of Trigonometric Functions – The ChainRule and Parametric Equations – Implicit Differentiation – Linearization and Differentials.Chapter 2- Sec: 2.1 to 2.7 and
Chapter 3- Sec: 3.1 to 3.6, 3.7, SelfStudy - Sec: 3.7.

Application of Derivatives: Extreme values of Functions – The Mean Value Theorem   – Monotonic Functions and the First Derivative Test – Concavity and Curve Sketching –   Intermediate Forms and L' Hospital's Rule – Anti Derivatives.
Chapter 4- Sec: 4.1 to 4.4, 4.6 to 4.8, SelfStudy - Sec: 4.5

The Definite Integral – The Fundamental Theorem of Calculus – Indefinite Integrals and the Substitution Rule – Substitution and Area between Curves.
Chapter 5- Sec: 5.1 to 5.6

Techniques of Integration: Basic Integration Formulas – Integration by Parts – Integration of Rational Functions by Partial Fractions – Trigonometric Integrals – Trigonometric Substitutions – Numerical Integration – Improper Integrals.
Chapter 8: 8.1 to 8.5, 8.7,8.8, SelfStudy - Sec: 8.6

Application of Definite Integrals: Volumes by Slicing and Rotation about an Axis – Volumes by Cylindrical Shells – Lengths of Plane Curves – Moments and Centre of Mass – Areas of Surface of Revolution and the Theorems of Pappus – Work – Fluid Pressure and Forces.
Chapter 6 – Sec: 6.1 to 6.7

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

REFERENCE BOOKS:
   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.

24MAT106   Discrete Mathematics   3 1 0 4

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 -1.3, 1.5 -1.7, 2.3, 4.1 - 4.4, 5.1 - 5.3 and 5.5)

Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions. (Sections: 7.1, 7.3 - 7.6)

Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion. (Sections: 6.1 - 6.6)

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: 8.1 - 8.8)

TEXT BOOK:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw-Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.

REFERENCES:

1. 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 , 2004.

24PHY103   Physics   3 0 0 3

Objective of the course
The objective of the course is to make students understand how physics is applied to the phenomena observed in the real world. The course also aims in enhancing the problem-solving skills using techniques that require mathematical skills, conceptual and mathematical models.At the end of the course students **will be able to**:

CO1 : understand basic physics associated with kinematics in 1,2,&3 dimensions, explain the meaning of conservation(energy& Momentum) and use it to compare the changes occurring during collision of two objects

CO2 : apply Newton's law of universal gravitation to find the gravitational force between two masses ,use Kepler's law of harmonies to make calculations regarding the radius and period of orbits of planets.

CO3 : Understand rigid bodies, draw clear and appropriate free body diagrams. determine the mass moments and products of inertia for arbitrary rigid bodies, analyse the motion of rotating systems, calculate the inertia tensor for simple objects

CO4 :. understand Variance& invariance, check invariance of different laws of Physics under Galilean transformations& explain the meaning and significance of the postulate of Special Relativity.

CO5 : understand the fundamentals of the mechanics of continuous systems, solve problems based on principle of least action and write Lagrangian for mechanical system in terms of generalised coordinates

Skills Acquired : Develops logical skills in applying and analysing problems in mechanics

Unit –I: Force, Energy, Momentum & Collisions   **(8 Hr)**

Learning objectives

After completing this chapter, student will be able to
LO1- solve problems based on Newtons laws of motion.
LO2- identify types of mechanical energy possessed by an object.
LO3 -predict whether an object's total mechanical energy would be conserved or not conserved based upon the types of forces which are doing work upon the object.
LO4 - apply the principles of energy conservation to a various of physical situations.
LO5- determine the momentum of total system and to state what momentum conservation is.
LO6- apply the principle of momentum conservation to solve collision problems.
One-, two- and three-dimensional motion under forces – Energy and momentum conservation- collision in one and two dimensions.

Unit-II: Gravitation & Kepler's laws   (10 Hr)

Learning objectives

After completing this chapter, student will be able to
LO1- calculate the gravitational force experienced by two objects.
LO2- Relate Kepler's laws to Newton's universal law of gravitation
LO3- solve problems based on the concept of gravitational potential energy
LO4- apply Kepler's law to find the characteristics of orbit
Newton's laws- Gravitation- Central force motion and application to planetary motion- Kepler's laws

Unit-III: Rotational dynamics   (10 Hr)
Learning objectives
After completing this chapter, student will be able to
LO1- construct appropriate free-body diagrams and solve problems in two-dimensional rigid-body dynamics.
LO2- Apply appropriate mathematical equations to solve problems based on torque and moment of inertia.
LO3- Understand the inertia matrix and the principal moments and principal directions at any point in a rigid body or system of particles
Rotational motion of a rigid body, Potential energy, Euler's angles-Euler's Equation-Moment of inertia tensor

Unit- IV: Special Theory of relativity   (7 Hr)
Learning objectives
After completing this chapter, student will be able to
LO1- understand the concept of constant relative motion of different bodies in different frames of references
LO2- use Lorentz transformations to apply the concepts of length contraction and time dilation
LO3-Describe relativistic effects seen in conservation of momentum and perform calculations involving mass energy equivalence

Frames of reference, Galilean relativity, non-inertial frames, Lorentz transformation-basic special relativity- velocity addition- Relativistic momentum

Unit – V: Lagrangian formalism   (10 Hr)
Learning objectives

After completing this chapter, student will be able to
LO1- Apply variational calculus to demonstrate principle of least action
LO2- define generalised coordinates, generalised velocities, generalised force
LO3- Identify the motion of a mechanical system using Lagrange formalism
LO4- qualitatively analyze, understand the mechanical systems
1.   Least action principle, phase space, Langarangian Formulation-Applications

Text Book

1. Principles of Physics, Walker, Halliday & Resnick, Wiley, Tenth Edition
2. Mechanics: C. Kittel, W.D. Knight, M.A. Ruderman, C.A. Helmholz and B.J. Moyer (2008) Berkeley Physics Vol 1, Tata McGraw-Hill Ltd
3. Feynman Lectures in Physics Vol:1 : Feynman, R. P., Leighton, R. B., & Sands, M. L, Pearson (2020)
4.
5. Reference Books
6. Classical Mechanics: R.D. Gregory (2008) Cambridge University Press
7. Introduction to Classical Mechanics: D. Morin (2009) Cambridge University Press
8. Classical Mechanics: J.R. Taylor (2005) University Science Books
9. Mechanics: L.D. Landau and I.M. Lifshitz (2007) 3 edition, Butterworth-Heinemann

24CSC101   Problem Solving and Python Programming   3 0 0 3

Conceptual introduction: Topics in computer science, algorithms; modern computer systems: hardware architecture, data representation in computers, software and operating system; Installing Python; basic syntax, interactive shell, editing, saving, and running a script. The concept of data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages.

Conditions, boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation. Strings and text files; manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary,

octal, hexadecimal numbers.

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries. Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Recursive functions. Testing, Debugging, Exceptions, Assertions. Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects.

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

24CSC181   Problem Solving and Python Programming Lab   0 0 2 1

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. Building stand alone Python scripts
5. Implementing logic requiring conditional expressions and looping
6. Working with strings using inbuilt functionalities of the datatype
7. Working with Python inbuilt datatypes like Lists, Tuples and Dictionaries
8. Working with modularity : Implementing functions and designing logic in a modular fashion
9. Implement unit testing measures assertions and exception handling
10. Use Python to model object oriented programming principles using various use cases.

Text Book

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

24PHY183   Physics Lab   0 0 2 1

1. Young's modulus – Uniform bending
2. Torsional Pendulum
3. Compound Pendulum
4. Coefficient of viscosity- Poiseuille's method

5. Surface tension of liquid by capillary raise method
6. Thermal conductivity of bad conductor - Lee's disc
7. Kundt's tube
8. Specific heat capacity of a liquid by method of cooling.

Text Book: Laboratory manual supplied by the Department

22ADM101 FOUNDATION OF INDIAN HERITAGE	L-T-P-C: 2-0-1-2

Course Objectives

The course will enable the students to

- This Course offers students an opportunity to delve into the depths and richness of the Indian culture and knowledge traditions.
- It aims to provide a synoptic view of the grandiose achievements of India across diverse fields, enabling students to develop a comprehensive understanding of their country and its eternal values.
- Aligned with the Indian Knowledge Systems (IKS) framework outlined in the National Education Policy, this course serves as an introduction to the vast reservoir of wisdom and knowledge rooted in Indian heritage.
- By the end of this course, students will develop a sense of pride in their heritage, appreciate the eternal values of India, and recognize the relevance of Indian wisdom in the modern world.
- This also explores the historical contributions of India in various fields such as mathematics, science, medicine, astronomy, and architecture.

Course Outcomes:

After successful completion of the course, Students will be able to:

Sl.No.	Course Outcomes	Knowledge level [Bloom's Taxonomy]
CO01	Recall key historical events, philosophies, and perspectives presented in the chapters on Indian heritage. Statement: Demonstrate the ability to remember significant historical events, philosophical concepts, and diverse viewpoints discussed in the chapters on Indian heritage.	Remembering
CO02	Explain the interconnectedness of Indian heritage, philosophy, and culture (as presented across various chapters). Statement: Understand the intricate relationships between chapters, recognizing how Indian heritage, philosophies, and cultural elements form a cohesive tapestry	Understanding

CO03	Apply principles from chapters on becoming a strategic thinker, personality development through yoga, and compassion to real-life scenarios. Statement: Utilize insights gained from chapters on strategic thinking, yoga, and compassion to address contemporary challenges and personal growth.	Applying
CO04	Analyze the impacts of colonialism, historical timelines, and foreign perspectives on India's identity, (as discussed in relevant chapters). Statement: Deconstruct the influences of colonialism, historical evolution, and foreign views on India, assessing their implications for the nation's heritage	Analyzing
CO05	Evaluate the significance of Indian Mahatmas and Advaita Vedanta in shaping Indian traditions and values (drawing from relevant chapters). Statement: Assess the lasting impact of Indian Mahatmas and Advaita Vedanta on India's cultural and spiritual landscape, considering their contributions and relevance	Evaluating
CO06	Develop projects that integrate themes of life, happiness, nature, celebration, and selflessness, (drawing inspiration from multiple chapters). Statement: Create innovative projects that synthesize themes from various chapters, reflecting the holistic and multifaceted nature of Indian heritage.	Creating

CO-PO Mapping: [affinity#: 3 – high; 2- moderate; 1- slightly]

COs	Program Outcomes [POs]												Program Specific Outcomes [PSOs]*			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO01												3				
CO02							2	2	2			2				
CO03			2			3	2	3	2							
CO4						2		2				3				
CO5						3	3	2	2			2				
CO6						3		3				3				

Syllabus:

Chapter 1 -   Educational Heritage of Ancient India

Chapter 2 -   Life and Happiness

Chapter 3 -   Impact of Colonialism and Decolonization

Chapter 4-   A timeline of Early Indian Subcontinent

Chapter 5 -   Indian approach towards life

Chapter 6 -   Circle of Life

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
CO 1	Illustrate comprehension of the fundamentals of writing
CO 2	Analyse audio text focussing on English phonetics, pronunciation and meaning comprehension
CO 3	Apply theoretical knowledge to write professional documents
CO 4	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. Felixa Eskey. *Tech Talk*, University of Michigan. 2005
2. Michael Swan. *Practical English Usage*, Oxford University Press. 2005
3. Anderson, Paul. *Technical Communication: A Reader Centered Approach*, V Edition, Hercourt, 2003.
4.   Martinet, Thomson, *A Practical English Grammar*, IV Ed. OUP, 1986.
5. Raymond V. Lesikar and Marie E. Flatley. *Basic Business Communication*, Tata McGraw Hill Pub. Co. New Delhi. 2005. Tenth Edition.
6. Thampi, G. Balamohan. *Meeting the World: Writings on Contemporary Issues*. Pearson, 2013.
7. Lynch, Tony. *Study Listening*. New Delhi: CUP, 2008.
8. Kenneth, Anderson, Tony Lynch, Joan Mac Lean. *Study Speaking*. New Delhi: CUP, 2008.
9. Marks, Jonathan. *English Pronunciation in Use*. New Delhi: CUP, 2007.
10. Syamala, V. *Effective English Communication for You (Functional Grammar, Oral and Written Communication)*: Emerald, 2002.
11. Sample Question Papers from Competitive Examinations
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

21HIN111   **HINDI II**   **2 0 0 2**

Unit -1
a) Visheshan- ParibhashaAurBhed.special usage of adverbs, changing voice and conjunctions in sentences.
b) kriya- ParibhashaAurBhed, rupantharkidrushti se-kaal
c) padhparichay.
d) Vigyapan Lekhan (Advertisement writing),   Saar Lekhan (Precise writing).

Unit -2
Communicative Hindi – MoukhikAbhivyakthi –understanding proper pronunciation, Haptics …etc in Interviews, short speeches.

Unit -3
Film review,Audio –Visual-Media in Hindi – Movies appreciation and evaluation.News reading and presentations in Radio and Tv channels in Hindi, samvaadhlekhan,

Unit -4

a) Harishankarparasaiyi- SadacharkaThavis
b) Jayashankarprasadh – Mamata
c) Mannubandari- Akeli
d) Habibtanvir- Karthus

Unit -5
a) Kavya Tarang
b) Himadri thung shrung se (poet- Jayasankar prasad)
c) Dhabba (poet- kedarnath sing) ,
d) Proxy (poet- Venugopal),
e) Machis(poet –Suneeta Jain) ,
f) Vakth.   (poet – Arun kamal)
g) Fasal (poet- Sarveshwar Dayal Saxena)

21KAN111   KANNADA II   2 0 0 2

Objectives:
   a) To enable the students to acquire basic skills in functional language.
   b) To develop independent reading skills and reading for appreciating literary
       works.
   c) To develop functional and creative skills in language.
   d) To enable the students to plan, draft, edit & present a piece of writing.

UNIT – 1

   a) Bettada Melondu Maneya Maadi – Akka Mahadevi
   b) Thallanisadiru Kandya – Kanakadasa
   c) Avva – P. Lankesh
   d) Neevallave – K. S. Narasimha Swamy

UNIT – 2

   Gunamukha – Drama by P. Lankesh

   UNIT – 3

   Karvalo – Novel by Poornachandra Thejaswi

   UNIT – 4

Letter Writing –
Personal (congratulation, invitation, condolence etc.)
   a) Official (To Principal, Officials of various departments, etc.,)
   b) Report writing
   c) Essay writing
   d) Precise writing

Prescribed text:

a) Gunamukha by P. Lankesh (Lankesh Prakashana)
b) Karvalo by Poornachandra Thejaswi (Mehtha publishing house)

Reference
a) Saamanyanige Sahithya Charitre (chapter 1 to 10) – Bangalore University Publication
b) Hosa Kannada Saahithya Charithre – L.S Sheshagiri Rao
c) Kacheri Kaipidi – Kannada Adhyayana Samsthe (Mysuru University)
d) Kannada Sahithya Charithre – R. Sri Mugali
1. H.S.Krishna Swami Iyangar – *Adalitha Kannada – Chetana Publication, Mysuru*

21MAL111   Malayalam II   2 0 0 2

Unit1
    Ancient poet trio: Kalayanasougandhikam,(Lines: kallum marangalum… namukkennarika vrikodara),KunjanNambiar - Critical analysis of his poetry-Ancient Drama: Kerala Sakunthalam (Act 1), Kalidasan (Transilated by Attor Krishna Pisharody).

Unit 2
     Modern/romantic/contemporary poetry: Chandanakkattil –G.Sankara kurupu-Romanticism – modernism.

Unit 3
     Memoirs from Modern Poets: Theeppathi, Balachandran Chullikkadu-literary contributions of his time.

Unit 4
     Partof an autobiography/travelogue: Kannerum Kinavum, Chapter: Valarnnu Varunnoratmavu, V.T.Bhattathirippadu-Socio-cultural literature-historical importance.

Unit 5
     Error-free Malayalam-**1**.Language; **2**.Clarity of expression; **3**.Punctuation-Thettillatha Malayalam-Writing-**a**.Expansion of ideas;**b**.PrécisWriting;**c.** Essay Writing; **d**.Letter writing;**e**.RadioSpeech;**f**.Script/Feature/ScriptWriting;**g**.NewsEditing;**h.**Advertising;**i**.Editing; **j**.EditorialWriting;**k**.Critical appreciation of literary works (Any one or two as an assignment).

21SAN111   SANSKRIT II   2 0 0 2

Module I
    Seven cases, Avyayas, sentence making with Avyayas, Saptha kakaras. **(5hrs)**

Module II
> Kthavathu' Prathyayam, Upasargas, Kthvatha,Thumunnantha, Lyabantha
Prathyayam. Three Lakaras – brief introduction, Lot lakara   **(5hrs)**

Module III
New words and sentences for the communication, Slokas, moral stories(panchathanthra) Subhashithas, riddles (Selected from the Pravesha Book) **(5hrs)**

Module IV
 Introduction to classical literature, classification of Kavyas, classification of Dramas - Important five Maha kavyas   **(5hrs)**

Module V
Translation of paragraphs from Sanskrit to English and wise –verse   **(5hrs)**

Module VI
> Bhagavad - Geeta fourteenth chapter (all 27 Shlokas)   **(5hrs)**

Essential Reading:
1, Praveshaha; Publisher: Samskrita bharati, Aksharam, 8th cross, 2nd phase, girinagar,
   Bangalore -560 085
2, Sanskrit Reader I, II and III, R.S. Vadhyar and Sons, Kalpathi, Palakkad
3, PrakriyaBhashyamwritten and published by Fr. John Kunnappally
4, Sanskrit Primer by Edward Delavan Perry, published by Ginn and Company Boston
5, Sabdamanjari, R.S. Vadyar and Sons, Kalpathi, Palakkad
6, Namalinganusasanam by Amarasimha published by Travancore Sanskrit series
7, SubhashitaRatnaBhandakara by Kashinath Sharma, published by Nirnayasagarpress

24MAT115   VECTOR CALCULUS   3 1 0 4

Calculus of vector-valued functions: Vector-valued functions of a real variable-Algebraic operations. Components- Limits, derivatives and integrals-Applications to curves. Tangency- Applications to curvilinear motion-Velocity, speed and acceleration-The unit tangent, the principal normal -The definition of arc length.

Vol.1, Chapter 14- Sec. 14.1 to 14.10.

Differential calculus of scalar and vector fields: Functions of R^ntoR^m.Scalar and vector fields-Open balls and open sets-Limits and continuity-The derivative of a scalar field with respect to a vector-Directional derivatives and partial derivatives-Partial derivatives of higher order-Directional derivatives and continuity-The total derivative-The gradient of a scalar field-A chain rule for derivatives of scalar fields-Applications to geometry. Level sets. Tangent planes

Vol.2, Chapter-8-Sec. 8.1 to 8.17.

Line Integrals: Introduction-Paths and line integrals-Other notations for line integrals-Basic properties of line integral-Open connected sets. Independence of paths-The second fundamental theorem of calculus for line integrals-The first fundamental theorem of calculus for line integrals-Necessary and sufficient conditions for a vector field to be gradient-Necessary conditions for a vector field to be gradient-Special methods for constructing potential functions.

Vol.2, Chapter-10-Sec 10.1 to 10.5, 10.10 and 10.11, 10.14 to10.18.

Multiple Integrals: Introduction-Green's theorem in the plane-Some applications of Green's theorem-A necessary and sufficient condition for a two-dimensional vector field to be a gradient-Change of variables in double integral-Special cases of transformation formula.

Vol.2, Chapter-11-Sec. 11.19 to 11.22, 11.26 to 11.28.

Surface Integrals: Parametric representation of a surface-The fundamental vector product- The fundamental vector product as a normal to the surface-Surface integrals-Other notations for surface integrals-The theorem of Stokes-The curl and divergence of a vector field- Further properties of the curl and divergence-The divergence theorem (Gauss' theorem)

Vol.2, Chapter-12-Sec. 12.1 to 12.4, 12.7,12.9 to12.15, 12.19 and 12.21.

TEXT BOOKS:

Howard Anton, IRl Bivens, Stephens Davis, "Calculus" Wiley, 10th Edition, 2016 Reprint.
Tom M. Apostol, CalculusVolume1, John Wiley & Sons, Second edition, 2007.
Tom M. Apostol, Calculus Volume 2, John Wiley & Sons, Second edition, 2007.

REFERENCE BOOKS:

a) Howard Anton "Calculus" John Wiley and Sons
b) Murray R Spiegel, Theory and problems of vector analysis, Schaum's outline series, McGraw-Hill Book Compnay 1974.
c) Finney and Thomas , Calculus, Pearson, Eleventh Edition, 2008.

24MAT116   Linear Algebra   3 0 2 4

Vector Spaces: Vector spaces - Sub spaces - Linear independence - Basis – Dimension.
Inner Product Spaces: Inner products - Orthogonality - Orthogonal basis - Gram Schmidt Process - Change of basis - Orthogonal complements - Projection on subspace - Least Square Principle.

Linear Transformations: Positive definite matrices - Matrix norm and condition number - QR- Decomposition - Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Change of basis - Nilpotent transformations - Trace and Transpose, Determinants, Symmetric and Skew Symmetric

Matrices, Adjoint and Hermitian Adjoint of a Matrix, Hermitian, Unitary and Normal Transformations, Self Adjoint and Normal Transformations, Real Quadratic Forms.

Eigen values and Eigen vectors: Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms, Conic Sections. Similarity of linear transformations - Diagonalisation and its applications - Jordan form and rational canonical form.

TEXT BOOK
1.Howard Anton and Chris Rorres, "Elementary Linear Algebra", Tenth Edition, John Wiley & Sons, 2010.

REFERENCES:
a) Nabil Nassif, Jocelyne Erhel, Bernard Philippe, Introduction to Computational Linear Algebra, CRC press, 2015.
b) Sheldon Axler, Linear Algebra Done Right, Springer, 2014.
c) Gilbert Strang, "Linear Algebra for Learning Data", Cambridge press, 2019.
d) Kenneth Hoffmann and Ray Kunze, Linear Algebra, Second Edition, Prentice Hall, 1971.
e) Mike Cohen, Practical Linear Algebra for Data Science, Oreilly Publisher, 2022.

24CSC111　　Advanced Computer Programming　　3 0 0　3

Working with packages: How to install/import and use an external Python package. Popular Python packages for applied data science: Exercises to understand usage of libraries like Numpy, SciPy, Pandas in interpreted and script modes.

Applied Plotting, Charting & Data Representation in Python: Fundamentals of data reading, streams etc and using Pandas, Basic Charting using Matplotlib, Advanced plots, interactive plots and animated plots, Plotting with Pandas, Seaborn.

Python packages for accessing the Web Data: Regex, urlib, BeautifulSoup, Json, Retrieving and parsing webpages (Json, XML), REST API, Facebook and Twitter API. Connecting DB with Python: Reading and Writing, possible simple SQL queries.

Text Book:

1. 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

24CSC112　　　Computer Architecture　　3 0 2　4

Number Systems: Decimal system – Positional number systems – Binary system – Converting between binary and decimal – Hexadecimal notations. Computer Arithmetic: ALU – Integer representation – Integer arithmetic – Floating-point

representation – Floating-point arithmetic. Digital Logic: Boolean algebra – Gates – Combinational circuits – Sequential circuits.

Fixed point Addition, Subtraction, Multiplication and Division. Floating Point arithmetic, High performance arithmetic, Subword parallelism

Input / Output Concepts And Terminology – Buses And Bus Architectures – Programmed And Interrupt-Driven I/O – A Programmer"s View Of Devices, I/O, And Buffering.

Memory hierarchy, Memory Chip Organization, Cache memory, Virtual memory. Parallel Bus Architectures, Internal Communication Methodologies, Serial Bus Architectures, Mass storage, Input and Output Devices.

Parallelism: Introduction – Parallel And Pipelined Architectures – Characterizations Of Parallelism -Types of parallelism and parallel architectures (Flynn classification) – Communication, Coordination, And Contention – Performance Of Multiprocessors – Consequences For Programmers – Redundant Parallel Architectures – Distributed And Cluster Computers. Data Pipelining: The concept of pipelining – Software pipelining – Software pipelining and Hardware pipelining.

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", 10th Global Edition, Pearson Education Limited, 2016.
2. Douglas Comer, "Essentials of Computer Architecture", 2nd Edition, CRC Press, 2017.

24CSC182 ADVANCED COMPUTER PROGRAMMING LAB 0 0 2 1

Programs to demonstrate functions call by reference and returning values by reference. Programs using pointer arithmetic operations and handling pointers. Programs to demonstrate dynamic memory allocation and de-allocation. Programs to show structure and union operations. Programs using files, command line arguments and macros. Programs using user defined libraries and graphics library.

22ADM111	GLIMPSES OF GLORIOUS INDIA	L-T-P-C: 2-0-1-2

Course Objectives

The course will enable the students to

- The course aims at introducing Bhārath in nutshell to the student, which includes the sources of Indian thoughts, eminent personalities who shaped various disciplines, India's significant contribution to the man kind, the current stature of Indian in the geopolitics and Indian approach to science and ecology
- This course is designed to provide a multifaceted understanding of India's cultural heritage, encompassing historical insights, philosophical perspectives, and contemporary relevance. By delving into diverse chapters, this course aims to foster deep insights into the intricate web of India's past, present, and its role on the global stage.
- Aligned with the Indian Knowledge Systems (IKS) framework outlined in the National Education Policy, this course serves as an introduction to the vast reservoir of wisdom and knowledge rooted in Indian heritage.

Course Outcomes:

After successful completion of the course, Students will be able to:

S.No.	Course Outcomes	Knowledge level [Bloom's Taxonomy]
CO01	Recall key historical events, personalities, and philosophical concepts presented in the chapters on Indian heritage. Statement: Demonstrate the ability to remember significant historical events, noteworthy individuals, and fundamental philosophical ideas discussed in the chapters on glorious India.	Remembering
CO02	Explain the diverse roles of women, the teachings of Acharya Chanakya, and the concepts of God and Iswara as foundational elements of Indian culture. Statement: Understand the significance of women's roles, Chanakya's teachings, and spiritual concepts, appreciating their contributions to Indian society.	Understanding
CO03	Apply lessons from the Bhagavad Gita to real-life scenarios, demonstrating the relevance of its teachings. Statement: Utilize insights from the Bhagavad Gita to navigate challenges, transforming from a soldier to a seeker on a spiritual journey.	Applying
CO04	Analyze the synthesis of yoga, spirituality, and life principles in Indian culture, as explored in the chapters on Bhagavad Gita and Lessons of Yoga. Statement: Deconstruct the integration of yoga and spiritual wisdom in Indian culture, examining how these principles enhance holistic well-being.	Analyzing
CO05	Evaluate the impact of Indian soft power, the preservation of nature through faith, and ancient Indian cultures on global perceptions.	Evaluating

CO	Statement	
	Statement: Assess the influence of India's cultural soft power, environmental values, and ancient traditions on its international image and ecological practices.	
CO06	Develop projects that illustrate Indian contributions to the world, practical applications of Vedanta, and the Indian approach to science. Statement: Create innovative presentations or projects that showcase India's global influence, practical insights from Vedanta, and unique scientific perspectives inspired by Indian thought.	Creating

CO-PO Mapping: [affinity#: 3 – high; 2- moderate; 1- slightly]

COs	Program Outcomes [POs]												Program Specific Outcomes [PSOs]*			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO01						3						2				
CO02						2		3	2			2				
CO03		2	2			3	2	3	2	2		3				
CO04			3			3						3				
CO05						3	2	2	2			2				
CO06	1	2	2		2	2						2				

Syllabus

Chapter 1 –   Face the Brutes
Chapter 2 –   Role of Women in India
Chapter 3 –   Acharya Chanakya
Chapter 4 –   God and Iswara
Chapter 5 –   Bhagavad Gita: From Soldier to Samsarin to Sadhaka
Chapter 6 –   Lessons of Yoga from Bhagavad Gita
Chapter 7 –   Indian Soft powers
Chapter 8 –   Preserving Nature through Faith
Chapter 9 -   Ancient Indian Cultures (Class Activity)
Chapter 10 -   Practical Vedanta
Chapter 11 -   To the World from India (For Continuous Assessment)
Chapter 12 -   Indian Approach to Science
Chapter 13 -   India: In the Views of foreign Scholars and Travellers.
Chapter 14 -   Personality Development Through Yoga.
Chapter 15 -   Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness
Chapter 16 -   Conversations on Compassion with Amma

Textbooks:
Glimpses of Glorious India

Reference Books:
Topic wise PPTs will be uploaded in Teams

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

1. Course Overview

Master Over the Mind (MAOM) is an Amrita initiative to implement schemes and organise university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3). This program as part of our efforts for sustainable stress reduction gives an introduction to 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, Sri Mata Amritanandamayi Devi (Amma), this course has been planned to be offered to all students of all campuses of AMRITA, starting off with all first years, wherein one hour per week is completely dedicated for guided practical meditation session and one hour on the theory aspects of MAOM. The theory section comprises lecture hours within a structured syllabus and will include invited guest lecture series from eminent personalities from diverse fields of excellence. This course will enhance the understanding of experiential learning based on university's mission: "Education for 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.

2. Course Syllabus

Unit 1 (4 hours)

Causes of Stress: The problem of not being relaxed. Need for meditation -basics of stress management at home and workplace. Traditions and Culture. Principles of meditation– promote a sense of control and autonomy in the Universal Human Value System. Different stages of Meditation. Various Meditation Models. Various practices of Meditation techniques in different schools of philosophy and Indian Knowledge System.

Unit 2 (4 hours)

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 (4 hours)

Communications: principles of conscious communication. Relationships and empathy: meditative approach in managing and maintaining better relationships in life during the interactions in the world, 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. Methodologies to evaluate effective awareness and relaxation gained from meditation. Evaluating the global transformation through meditation by instilling human values which leads to service learning and compassion driven research.

TEXT BOOKS:
1.Mata Amritanandamayi Devi, "Cultivating Strength and vitality," published by Mata Amritanandamayi Math, Dec 2019
2.Swami Amritaswarupananda Puri ,"The Color of Rainbow " published by MAM, Amritapuri.

 REFERENCES:
1.Craig Groeschel, "Winning the War in Your Mind: Change Your Thinking, Change Your Life" Zondervan Publishers, February 2019

2.R Nagarathna et al, "New Perspectives in Stress Management "Swami Vivekananda Yoga Prakashana publications, Jan 1986

3. Swami Amritaswarupananda Puri "Awaken Children Vol 1, 5 and 7 - Dialogues with Amma on Meditation", August 2019
4. Swami Amritaswarupananda Puri "From Amma's Heart - Amma's answer to questions raised during world tours" March 2018
5. Secret of Inner Peace- Swami Ramakrishnananda Puri, Amrita Books, Jan 2018.
6. Mata Amritanandamayi Devi "Compassion :The only way to Peace:Paris Speech", MA Center, April 2016.
7. Mata Amritanandamayi Devi "Understanding and collaboration between Religions", MA Center, April 2016.
8. Mata Amritanandamayi Devi "Awakening of Universal Motherhood: Geneva Speech" M A center, April 2016.

3. Evaluation and Grading

Internal			External	Total
Components	*Weightage*		Practical (attendance and class participation) 60%	100%
Quizzes(based on the reading material)	20%	40%		
Assignments (Based on webinars and lecture series)	20%			

4. Course Outcomes (CO)

CO1: Relate to the causes of stress in one's life.

CO2: Experiment with a range of relaxation techniques CO3:

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

CO4: Develop appropriate practice of MA-OM technique that is effective in one's life CO5:

Inculcate a higher level of awareness and focus.

CO6: Evaluate the impact of a meditation technique

*Programme Outcomes(PO)(As given by NBA and ABET)

PO1: Engineering Knowledge

PO2: Problem Analysis

PO3: Design/Development of Solutions

PO4: Conduct Investigations of complex problems

PO5: Modern tools usage

PO6: Engineer and Society

PO7: Environment and Sustainability

PO8: Ethics

PO9: Individual & Team work

PO10: Communication

PO11: Project management & Finance

PO12: Lifelong learning

CO – PO Affinity Map

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

24CSC201 **Data Structures** **3 0 0 3**

Abstraction - Abstract data types; Data Representation; Elementary data types; Basic concepts of data Structures; Mathematical preliminaries - big-Oh notation; efficiency of algorithms; notion of time and space complexity; performance measures for data structures.
ADT array - Computations on arrays - sorting and searching algorithms.

ADT Stack, Queue, list - array, linked list, cursor based implementations of linear structures. ADT Tree - tree representation, properties traversal of trees; ADT- Binary Trees – properties and algorithms, ADT Priority Queue - Heaps; heap-based implementations; applications of heaps - sorting; Search Tree - Binary search tree; balanced binary search trees - AVL tree; Applications of Search Trees - TRIE; 2-3-4 tree; concept of B-Tree. ADT Dictionary - array based and tree based implementations; hashing - definition and application .

Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

TEXTBOOKS:

1.   Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.

REFERENCES:

1.   Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.
2.   Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.
3.   Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.

24MAT204 **Algebra – I** **3 1 0 4**

Definition of Groups, Basic Examples of Groups including Symmetric Groups, Subgroups. Cyclic Groups and Factor Groups, Lagrange's Theorem. Normal Subgroups. Quotient Groups.
Homomorphisms, Kernal of a homomorphism, Automorphisms, Cauchy's Theorem and Sylow's Theorem for Abelian Groups, Cayley's Theorem.

Permutation Groups, Conjugate Elements, Normalizer of an Element, Index of Normalizer, Center of a Group, Cauchy's Theorem on Prime Order, the Number of Conjugate Classes $p(n)$ for a Permutation Group, Counting Principles, Cauchy Theorem.

TEXTBOOKs:
a) M.Artin, 'Algebra', Prentice Hall inc., 1994.
b) I. N. Herstein, 'Topics in Algebra', Second Edition, John Wiley and Sons, 2000.
c) Joseph A. Gallian, 'Contemporary Abstract Algebra', Cengage Learning, 2013.
d) John B. Fraleigh, 'A First Course in Abstract Algebra', Narosa Publishing House, 2003.

24MAT205   Computational Optimization   3 0 2 4

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

Convex sets: Affine and convex sets. Some important examples. Operations that preserve convexity.

Generalized   inequalities. Separating and supporting hyperplanes. Dual cones and generalized inequalities.

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

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

Duality: The Lagrange dual function. The Lagrange dual problem. Geometric interpretation.

Saddle-point interpretation. Optimality conditions. Perturbation and sensitivity analysis. Theorems of alternatives. Generalized inequalities.

TEXT BOOKS:
1. Stephen Boyd and 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 and Stanislaw H. Zak, "An Introduction to Optimization", Second Edition, Wiley-Interscience Series in Discrete Mathematics and Optimization, 2004.

24MAT206 **Analysis-I** **3-1-0-4**

Sets and Functions: – Mathematical Induction – Finite and Infinite Sets – The Algebraic and Order Properties of – Absolute Value and Real Line – The Completeness Property of – Applications of the Supremum Property – Applications of the Supremum Property, Intervals.

Sequence: Sequence and Series: Sequences and their Limits – Limits Theorems – Monotone sequences – Subsequences and Balzano – Weierstrass Theorem. The Cauchy criterion – Properly divergence sequences.

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 – Alternating Series Test, Dirichlet and Abel Test.

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

Continuous Functions: – Continuous Functions - Combinations of Continuous Functions –Continuous Functions on Intervals – Uniform Continuity – Continuity and Gauges – Monotone and Inverse Functions.

Text Books:

1. Robert G. Bartle and Donald R. Sherbert, "Introduction to Real Analysis", John Wiley andSons, Third Edition, 2000.

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

3. S. C. Malik and Savita Arora, "Mathematical Analysis", New Age International Publishers,Fourth Edition, 2012.

4. H.L. Royden and P. M. Fitzpatrick , "Real Analysis", Pearson Education Asia Limited, FourthEdition, 2010.

5. S. Kumaresan and Ajit Kumar, A Basic Course in Real Analysis, CRC Press.

24CSC202 **OPERATING SYSTEMS** **3 0 2 4**

Introduction to Operating Systems: Overview - Types of systems - Computer system operations - Hardware Protection - Operating systems services - System calls

- System structure - Virtual machines. Process Management: Process concepts-Process scheduling - Operations on Process - Cooperating process - Interprocess communication - Multithreading models - Threading issues - Thread types - CPU

scheduling–scheduling algorithms.

Process Synchronization: Critical section problem - synchronization hardware – Semaphores - Classical problems of synchronization - Critical regions – Monitors-Deadlocks - Deadlock characterization - Methods of handling deadlocks - Deadlock prevention – Avoidance - Detection and recovery.

Storage Management: Memory management – Swapping - Contiguous memory allocation. Paging – Segmentation - Segmentation with Paging - Virtual memory - Demand paging - Process creation – page replacement - Thrashing. File Systems: Directory structure - Directory implementation - Disk scheduling. Case study: Threading concepts in Operating systems, Kernel structures.

TEXT BOOK:

Silberschatz and Galvin, "Operating System Concepts", Ninth Edition, John Wiley and Sons, 2012.
REFERENCES:

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

24CSC281   C Programming and Lab   1 0 2 2

Basic Linux commands, programs using input/output statements, operators, control structures andloops. Programs using functions and recursions. Programs using numeric one-dimensional array, two-dimensional array. Programs using strings, string handling functions and string arrays.

Programs using passing arrays and strings to functions.

24CSC282   Data Structures Lab   0 0 2 1

Implementing Sample ADT, Templates - Stacks and Queues: Array implementation, Applications - Vector, Lists, using these STLs for other implementations -Linked list: Singly

and Doubly Linked Lists Implementation, Linked Stacks, D-Queue, Circular Queue - Implementing STL: Sequences, Iterators - Trees: Binary search tree, Priority Queue, Heaps - Graphs: Graph Representations, Traversals (BFS, DFS) - Hashing: Hash Table creation, creating hash functions, dynamically resizing hash tables.

Life Skills I	23LSK201	L-T-P-C: 1-0-2-2

Pre-requisite: An open mind and the urge for self-development, basic English language skills, knowledge of high school level mathematics.

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

Course Outcomes
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 overcoming nervousness, in situations like presentations, Group Discussions and interviews.
CO3: Aptitude – To analyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.
CO4: Aptitude - To investigate and apply suitable techniques to solve questions on logical reasoning.
CO5: Verbal – To infer the meaning of words & use them in the right context. To have a better understanding of the nuances of 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, emotional intelligence, presentation skills and problem-solving Skills.

CO-PO Mapping

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

Syllabus

Soft Skills

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 criticisms and feedback. Need for change in mindset and up-skilling to keep oneself competent in the professional world.

Managing Self: Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying 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, Square roots, 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 Problems on ages.

Logical Reasoning I: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, 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 enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words 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, by Amazon Publication.
3. Verbal Skills Activity Book, CIR, AVVP
4. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
5. The BBC and British Council online resources
6. Owl Purdue University online teaching resources
7. www.thegrammarbook.com online teaching resources
8. www.englishpage.com online teaching resources and other useful websites
9. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
10. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
11. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
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, R S Aggarwal.
15. A Modern Approach to Logical Reasoning, R S Aggarwal.
16. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

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

Courses offered under the framework of

Amrita Values Programmes I and II

22AVP201   Message from Amma's Life for the Modern World

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 in on matters which we consider as trivial are rich in content 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 become witness to all the happenings around us still keeping the balance of the mind.

22ADM211 Leadership from the Ramayana

Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

22ADM201 Strategic Lessons from the Mahabharata

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

22AVP204 Lessons from the Upanishads

Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, SatyakamaJabala, Aruni, Shvetaketu.

22AVP205   Message of the Bhagavad Gita

Introduction to Bhagavad Gita – Brief storyline of Mahabharata - Context of Kurukshetra War – The anguish of Arjuna – Counsel by Sri. Krishna – Key teachings of the Bhagavad Gita – Karma Yoga, Jnana Yoga and Bhakti Yoga - Theory of Karma and Reincarnation – Concept of Dharma – Concept of Avatar - Relevance of Mahabharata for modern times.

22AVP206 Life and Message of Swami Vivekananda

Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across 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

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

22AVP208   Insights into Indian Arts and Literature

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.

22AVP209 Yoga and Meditation

The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base 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.

22AVP210 Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a 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 9th to 12th 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

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led 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

Indian mode of worship is unique among the world civilizations. Nowhere in the world has the philosophical 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 the all-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

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 Bhīma and 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

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

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 where the paintings originated. The course introduces the painting styles such as Madhubani, Kerala Mural, Pahari, Cheriyal, Rajput, Tanjore etc.

22AVP220 Insights into Indian Classical Dance

The course takes the students through the ancient Indian text on aesthetics the Natyasastra and its commentary the AbhinavaBharati. 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

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 KalariPayattu. 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.

23ENV300   ENVIRONMENTAL SCIENCE   P/F

Course Objectives

a) To study the nature and facts about environment
b) To appreciate the importance of environment by assessing its impact on the human world
c) 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

Syllabus

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 – groundwater 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 – sustainabledevelopment.

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.

Semester 4

24MAT214   **Probability and Statistics with R**   **3 0 2 4**

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

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

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.

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.

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, John Wiley and Sons Inc., 2005
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.
3. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.
4. Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

24MAT215   **Algebra II**   **3 1 0 4**

Definition of Rings, Examples including Polynomial Rings, Formal Power Series Rings, Matrix Rings and Group Rings. Commutative Rings, Integral Domain, Division Ring, Characteristics of an Integral domain.

Homomorphisms, kernel, Isomorphism, Ideals, Quotient Rings, Maximal Ideals, the Field of Quotients of an Integral Domain.

Euclidean Rings, Principal Ideal, Unit Element, Greatest Common Divisor, Prime Elements, Unique Factorization Theorem, The ring of Gaussian integers, Fermat's Theorem.

Polynomial Rings – F[x], Degree of a Polynomial, The Division Algorithm, Principal Ideal Ring, Irreducible Polynomial a principal ideal ring, Irreducible polynomial, Polynomial Rings over the Rational Field, Primitive Polynomials, The Content of a Polynomial, Integer Monic Polynomial, Gauss Lemma, Eisenstein Criterion.

Polynomial Rings over Commutative Rings. Unique Factorization Domain. Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains, and their proper inclusions .

TEXTBOOK:
1. M.Artin, 'Algebra', Prentice Hall inc., 1994.
2. I. N. Herstein, 'Topics in Algebra', Second Edition, John Wiley and Sons, 2000.
3. Joseph A. Gallian, 'Contemporary Abstract Algebra', Cengage Learning, 2013.
4. John B. Fraleigh, 'A First Course in Abstract Algebra', Narosa Publishing House, 2003.

24MAT216   **Analysis II**   **3-1-0-4**

Basic Concepts: Definition and Examples of Metric Spaces, Distance between Sets and Diameter of a Set, Open Sets and Interior Points, Closed Sets and Closure of Sets, Subspaces.

Complete Metric Spaces and Separable Spaces: Convergent Sequences, Cauchy Sequences, Complete Metric Spaces, Completion. Separable Spaces, Countability, Dense Sets, Nowhere Dense Sets.

Definitions and Basic Concepts, Sequentially Compact Spaces,Totally Bounded Spaces.

Continuous Functions: Definition and Characterizations, Continuous Functions and Compact Spaces, Uniform Continuous Functions, Homeomorphism and Equivalent Metrics, Uniform Convergence of Sequences of Functions.

Connected Spaces: Separated Sets, Connected Sets, Continuous Functions and Connected Sets, Components.

Text books:

a) Qamrul Hasan Ansari, "Metric Spaces: Including Fixed Point Theory and Set-valued Maps" Alpha Science International, Ltd, 2010.
b) Mícheál Ó Searcóid, "Metric Spaces"; Undergraduate Texts in Mathematics, Springer-Verlag London Limited, 2007.
c) E. T. Copson, "Metric spaces", Cambridge Tracts in Mathematics, Cambridge University Press, 1988.

d) Tom M. Apostol Mathematical Analysis Narosa publishing house, New Delhi, 2nd Ed. 1989.

24CSC211   Design and Analysis of Algorithms   3 0 0 3

Introduction: Running time analysis -- recall of asymptotic notation, big-oh, theta, big-omega, and introduce little-oh and little-omega. Worst case and average case

Basic design paradigms with illustrative examples -- incremental design (e.g., incremental sorting, interpolating polynomials), decremental design (e.g., GCD with discussion on input size, factorial), and pruning (e.g., order statistics). Divide and Conquer: Integer multiplication revisited with an efficient algorithm that motivates and leads into recurrences. Solving recurrences using recurrence trees, repeated substitution, statement of master theorem. Brief recall of merge sort and its recurrence. Median in worst case linear time.

Greedy Algorithms: Greedy choice, optimal substructure property, minimum spanning trees -- Prims and Kruskals, Dijkstras shortest path using arrays and heaps, fractional knapsack, and Huffman coding (use of priority queue). Dynamic Programming: Integral knapsack (contrasted with the fractional variant), longest increasing subsequence.

Graph Algorithms – Graph Traversal BFS and DFS.

String Matching: Boyer Moore – KMP – Rabin Karp. NP-completeness: reduction amongst problems, classes NP, P, NP-complete, and polynomial time reductions.

Textbooks

1. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, Third Edition, 2009.

References

1. Algorithms, by Dasgupta, Papadimitrou and Vazirani, McGraw-Hill Education, 2006.
2. Algorithm Design, by Kleinberg and Tardos, Pearson, 2005.
3. Algorithm Design, by Goodrich and Tamassia, Wiley, 2001.

24CSC212   Database Management Systems   3 0 2 4

Introduction to DBMS:Database System Vs File system, Database systems applications, Purpose of database systems - Data models. Relational models: Structure of relational databases – database schema keys – schema diagrams. Relational Query Languages – fundamental relational algebra operations – additional relational algebra operations. Introduction to SQL – Background – SQL data definition –structure of SQL queries – set operations – null values - aggregate functions – modifications to the database.

Database design - overview of the design process – the entity-relationship model – constraints – entity-relationship diagrams – reduction to relation schemas - Entity-relationship design issues – weak entity sets – extended E-R features. Intermediate SQL: Nested subqueries - Join expression – Views – Transactions – integrity constraints – authorization. Advanced SQL – Accessing SQL from a program – functions and procedures – triggers.

Relational database design – features of good relational designs – atomic domains and normal forms - 1NF, 2NF, 3NF, 4NF and BCNF – decomposition using functional dependencies - functional dependency theory – algorithm for decomposition -decomposition using multi-values dependencies – PJNF and DKNF. Over view of Transaction Management and Concurrency control

Text Book:

1) Silberschatz. A., Korth, H. F. and Sudharshan, S. "Database System Concepts", 6th Edition, TMH, 2010

Reference Books
 a) Elmasri, R. and Navathe, S. B. "Fundamentals of Database Systems", 5th Edition, Addison Wesley, 2006
 b) Date, C. J. "An Introduction to Database Systems", 8th Edition, Addison Wesley, 2003.
 c) Ramakrishnan, R. and Gehrke, J. "Database Management Systems", 3rd Edition, McGrawHill, 2003.

24CSC283   Algorithm Lab   0 0 2 1

Implementation of common sorting algorithms – insertion sort, selection sort, quick sort, merge sort, bucket sort, radix sort. Greedy – task scheduling, fractional knapsack and other applications. Divide and Conquer – Closest Pair, Integer multiplication, other applications. Dynamic Programming – matrix chain multiplication, 0-1 knapsack, longest common subsequence, maximum contiguous subarray, edit distance. Graphs- minimum spanning tree algorithms, shortest path algorithms. String matching – KMP, Boyer Moore.

AMRITA VALUE PROGRAMME II   1 0 0 1

Sem: 4	Life Skills II	23LSK211	L-T-P-C: 1-0-2-2

Pre-requisite: Willingness to learn, communication skills, basic English language skills, 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.

Course Outcomes
CO1: Soft Skills - To improve the 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 questions on logical reasoning.
CO5: Verbal - To be able to use vocabulary in the right context and to be competent in spotting grammatical errors and correcting them.
CO6: Verbal - To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.
Skills: Communication, etiquette and grooming, inter-personal skills, listening skills, convincing skills, problem-solving skill.

CO-PO Mapping

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.

Verbal Skills

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

Grammar (Medium Level): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.

Reading Comprehension (Basics): Introduce students to smart reading techniques and help them understand different tones in comprehension passages.

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

Oral Communication Skills: Aid 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", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
9. www.englishpage.com online teaching resources and other useful websites
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, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

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

SEMESTER 5

24MAT302   COMPLEX ANALYSIS   3 1 0 4

Review: Algebra of complex numbers, operations of absolute value and conjugate, standard inequalities for absolute value.

Limits, Continuity, derivatives and analytic functions, Cauchy-Riemann equations, , Harmonic functions and harmonic conjugates, Power series, Exponential and Logarithmic functions.

Contour Integrals -Anti derivatives-Cauchy-Goursat theorem-Simply Connected Domains-Multiply Connected Domains, Cauchy's theorem for rectangle – Cauchy's theorem in a disk, An Extension of the Cauchy Integral Formula.

Taylors series, Laurent series; Isolated singularities: removable singularities, poles and essential singularities; Cauchy's residue theorem, Residues at Infinity, evaluation of definite integrals usingCauchy's residue theorem.

Evaluation of Improper Integrals -Improper Integrals from Fourier Analysis - Jordan's Lemma - Indented Paths - Definite Integrals Involving Sines and Cosines - Argument Principle. Rouche's theorem.

Linear Transformations-The Transformation $w = 1/z$ - Mappings by $1/z$ -Linear Fractional Transformations. (Chapter 8, Sec: 90-94).

TEXT BOOKS
a) James ward Brown, Ruel V. Churchill, Complex Variables and Applications, Eighth Edition, McGrawHill.
b) S. Ponnusamy, Foundations of Complex Analysis, 2nd Edition, Narosa Publishing House, 2005.
c) Conway, John B., Functions of One Complex Variable, II, Graduate Texts in Mathematics, 159, Springer-Verlag, New York, 1995.
d) Lars V. Ahlfors, Complex Analysis, 2ndEdition, McGrawHill, New York, 1966.

24MAT303   Statistical Inference Theory   3-0-2-4

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.

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.

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

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

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. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005
2. Amir D Azcel, Jayavel Sounderpandian, Palanisamy Saravanan and Rohit Joshi, Complete Business Statistics, 7th edition McGrawHill education 2012.
3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Probability and Statistics for Engineers and Scientists, 8th Edition, Pearson Education Asia, 2007.
4. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.
5. Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 2012.

24MAT304   DIFFERENTIAL EQUATIONS   4 0 0 4

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.

Equations solvable for $\frac{dy}{dx}$, y, x, equations in Clairaut's form, equations reducible to Clairaut's form.

Linear homogeneous differential equations with constant coefficients, Euler-Cauchy equation, Linear Nonhomogeneous Differential Equations: Wronskian, linear independence, Method of undetermined coefficients. Method of variation of parameters.

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.

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

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 $q = \frac{\partial z}{\partial y}$.

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.

TEXT BOOKS:

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

2. William E. Boyce and Richard C.DiPrima, Elementary differential equations and boundary value problems, Wiley india, 9th edition, 2012.

3. Nita H, Shah, Ordinary and Partial Differential Equations : Theory and Applications, PHI learning, 2nd edition, 2015.

4. Dennis Zill, A First Course in Differential Equations, Cengage Learning, 9th edition

24CSC301   Evolutionary Computing   3 0 0 3

Evolutionary Algorithms (Genetic Algorithms, Genetic Programming, Differential Evolution, Evolution Strategies, Covariance Matrix Adaptation etc.) – Different Components of Evolutionary Algorithms.
Fitness Landscapes – Adaptive Parameter Control and Tuning – Constraint Handling – Niching and Fitness Sharing – Memetic Algorithms – Ensemble Evolutionary Algorithms - Hybridization with other techniques – Multi-Objective Optimization – Hyper-Heuristics – Special Forms of Evolution (Co-evolution and Speciation) – Experimental (statistical) Methods for the analysis of Evolutionary Algorithms – Theoretical Analysis of Evolutionary Algorithms – Interactive Evolutionary Algorithms – Experiment design and analysis involving Evolutionary Algorithms
Evolutionary Machine Learning – Surrogate Assisted Optimization – NeuroEvolution – Quality Diversity Algorithms – Open Ended Evolution. Applications of Evolutionary Algorithms.
Text Books:
1. A. E. Eiben and J. E. Smith, "An Introduction to Evolutionary Computing", Natural Computing Series, Springer, 2nd Edition, 2015.
2. Eyal Wirsansky, "Hands-On Genetic Algorithms with Python: Applying Genetic Algorithms to Solve Real-World Deep Learning and Artificial Intelligence Problems", Packt Publishing, 2020.
3. Iaroslav Omelianenko, "Hands-on Neuroevolution with Python: Build High-Performing Artificial Neural Network Architectures using Neuroevolution-based Algorithm", Packt Publishing, 2019.

4. Slim Bechikh, Rituparna Datta and Abhishek Gupta (Eds.), "Recent Advances in Evolutionary Multi-objective Optimization", Adaptation, Learning, and Optimization Book – 20, Springer, 2017.
5. Nelishia Pillay and Rong Qu, "Hyper-Heuristics: Theory and Applications", Springer, 2018.
6. Hitoshi Iba, "Evolutionary Approach to Machine Learning and Deep Neural Networks: Neuro-Evolution and Gene Regulatory Networks", Springer, 2018.

24CSC302 THEORY OF COMPUTATION 3 0 2 4

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

Regular Expressions - Non-Regular Languages - Pumping Lemma for regular languages.

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, Computability Theory: Turing Machines - Non-deterministic Turing Machines –CSG, the Church Turing

thesis, decidability, halting problems, - PCP Computation histories – Reducibility.

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

REFERENCES:

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

| Life Skills III | 23LSK301 | L-T-P-C: 1-0-2-2 |

Pre-requisite: Team Spirit, self-confidence and required knowledge, basic English language skills, knowledge of high school level mathematics.

Course Objective: To help students understand the nuances of leadership, know the importance of working in teams, face challenging situations, crack interviews, improve communication skills and problem-solving skills.

Course Outcomes
CO1: Soft Skills - To acquire the ability to work in teams, present themselves confidently and showcase their knowledge, skills, abilities, interests, practical exposure, strengths and achievements to potential recruiters through a resume, video resume, and personal interview.
CO2: Soft Skills - To have better ability to prepare for facing interviews, analyse interview questions, articulate correct responses and respond appropriately to convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.
CO3: Aptitude - To manage time while arriving at appropriate strategies to solve questions in geometry, statistics, probability and combinatorics.
CO4: Aptitude - To analyze, understand and apply suitable methods to solve questions on data analysis and data sufficiency.
CO5: Verbal - To use diction that is less verbose and more refined and to use prior knowledge of grammar to correct/improve sentences.
CO6: Verbal - To understand arguments, analyze arguments and use inductive/deductive reasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.
Skills: Communication, teamwork, leadership, facing interviews and problem-solving.

CO-PO Mapping

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

Syllabus

Soft Skills
Team Work: Value of teamwork in organizations, Definition of a team. Why team? Effective team building. Parameters for a good team, roles, empowerment and need for transparent communication, Factors affecting team effectiveness, Personal characteristics of members and its influence on team. Project Management Skills, Collaboration skills.

Leadership: Initiating and managing change, Internal problem solving, Evaluation and co-ordination, Growth and productivity, Importance of Professional Networking.

Facing an interview: Importance of verbal & aptitude competencies, strong foundation in core competencies, industry orientation / knowledge about the organization, resume writing (including cover letter, digital profile and video resume), being professional. Importance of good communication skills, etiquette to be maintained during an interview, appropriate grooming and mannerism.

Aptitude

Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.

Data Interpretation: Tables, Bar Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, and other forms of data representation.

Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.

Campus recruitment papers: Discussion of previous year question papers of all major recruiters of Amrita Vishwa Vidyapeetham.

Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

Verbal Skills

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.

Grammar (Advanced Level): Enable students to improve sentences through a clear understanding of the rules of grammar.

Reasoning Skills: Facilitate the student to tap his reasoning skills through Syllogisms, and critical reasoning arguments.

Reading Comprehension (Advanced): Enlighten students on the different strategies involved in tackling reading comprehension questions.

Public Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.

Writing Skills: Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style. Practice formal written communication through writing emails especially composing job application emails.

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", New Delhi, India: Rupa & Co.
3. The Hard Truth about Soft Skills, by Amazone Publication.
4. Verbal Skills Activity Book, CIR, AVVP
5. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
6. The BBC and British Council online resources
7. Owl Purdue University online teaching resources
8. www.thegrammarbook.com online teaching resources
9. www.englishpage.com online teaching resources and other useful websites
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, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

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

24CSC381   **Open Lab-I**   **0 0 2 1**

The students can choose any of the following:

- JAVA Programming
- C++
- Web Design
- Algorithms.io
- Hadoop
- Cascading
- TensorFlow
- SAS (Statistical Software Suite)
- *Julia*

Evaluation: 60 marks for CA (weekly lab evaluation) + 40 marks for end semester

Semester -6

24CSC311   **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 subnetting and routing mechanisms.
4. Familiarity with the essential protocols of computer networks, and how they can be applied in
network design and implementation.
Network hardware, Network software, OSI, TCP/IP Reference models, Example Networks: ARPANET, Internet. Physical Layer: Guided Transmission media: twisted pairs, coaxial cable, fiber optics, Wireless transmission.

Data link layer: Design issues, framing, Error detection and correction. Elementary data link protocols: simplex protocol, A simplex stop and wait protocol for an error-free channel, A simplex stop and wait protocol for noisy channel.
Sliding Window protocols: A one-bit sliding window protocol, A protocol using Go-Back-N, A protocol using Selective Repeat, Example data link protocols. Medium Access sub layer: The channel allocation problem, Multiple access protocols: ALOHA,
Carrier sense multiple access protocols, collision free protocols. Wireless LANs, Data link layer
switching.

Network Layer: Design issues, Routing algorithms: shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, Congestion Control Algorithms, Quality of Service, Internetworking, The Network layer in the internet.

Transport Layer: Transport Services, Elements of Transport protocols, Connection management, TCP and UDP protocols.
Application Layer –Domain name system, SNMP, Electronic Mail; the World WEB, HTTP, Streaming audio and video.

TEXT BOOK:
a) James Kurose and Keith Ross, Computer Networking: A Top-Down Approach, 7th edition, Person Edition, 2018.
b) REFERENCE BOOKS:

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

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

c) Andrew S Tanenbaum, David. j. Wetherall, Computer Networks, , 5th Edition. Pearson

d) Education.

24CSC312   **Machine Learning**   **3 1 0 4**

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbors,

Decision Trees, Naïve Bayes. Linear models: Linear Regression, Logistic Regression, Generalized Linear

Models. Support Vector Machines, Nonlinearity and Kernel Methods. Beyond Binary Classification:

Multi-class/Structured Outputs, Ranking

Unsupervised Learning: Clustering: K-means/Kernel K-means. Dimensionality Reduction: PCA and kernel PCA. Matrix Factorization and Matrix Completion. Generative Models (mixture models and latent factor models)

Assorted Topics: Evaluating Machine Learning algorithms and Model Selection. Introduction to Statistical

Learning Theory. Ensemble Methods (Boosting, Bagging, Random Forests). Sparse Modelingand Estimation. Modeling Sequence/Time-Series Data. Deep Learning and Feature Representation Learning. Scalable Machine Learning (Online and Distributed Learning). A selection from some other advanced topics,e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models,

Introduction to Bayesian Learning and Inference.

Text books/ Reference books.

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Hal Daumé III, A Course in Machine Learning, 2015.

5. Dirk P. Kroese, Zdravko Botev, Thomas Taimre, Radislav Vaisman, Data Science and Machine Learning, Mathematical and Statistical Methods, CRC Press, 2019.
6. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 2014.

24CSC313   Data Mining and Warehousing   3 1 0 4

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Text Books:

1. Jiawei Han, Micheline Kamber and Jian Pei"Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.
2. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
3. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.

4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

24MAT312   Numerical Computations   3 0 2 4

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, system of nonlinear equations.

Solution of System of Linear Algebraic Equations, Gauss-Elimination, LU Decomposition and Gauss-Seidel, Conjugate gradient method.

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

Interpolation and Approximation: 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,

Solutions of Ordinary Differential Equations: Initial Value problems, Euler methods, Modified Euler method and Fourth order Runge-Kutta method. Boundary value problems using Forward Difference operators.

Solutions of Partial Differential equations: Elliptic, Parabolic and Hyperbolic equations implicit and explicit methods.

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,
3. 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
3. series in Pune and Applied Mathematics, McGraw Hill Book Co., 1980.
4. S. S. Sastry, Introductory methods of Numerical Analysis, 2012, PHI Publishers, 5th edition,

24MAT313 **Transform Techniques** **3 0 0 3**

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 Cosine Transforms, 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.

Text Book:

1. Larry C. Andrews and Bhimson. K. Shivamoggi, The Integral Transforms for Engineers, Spie Press, Washington, 1999.
2. L. Debnath, Integral transforms and their Applications, CRC Press, New York-
3. London- Tokyo, 1995
4. Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2016.
5. Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012.
6. Engineering Mathematics, Srimanta Pal and Subodh c Bhunia, Oxford press, 2015.

24CSC314 **Internet of Things** **1 0 2 2**

Introduction to loT - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels - A Case Study to realise the stack.

Sensors and Hardware for loT - Accelerometer, Proximity Sensor, lR sensor, Gas Sensor,Temperature Sensor, 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).

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).

Cloud and Data analytics- Types of Cloud - 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).

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)
2. lnfosys Training E Materials.
3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases',, by pethuru Rajand Anupama C. Raman (CRC press)
4. Adrian McEwen, Designing the internet of Things, Wiley (B November 2Ot3), ISBN-13:978-.11-L1,8430620,
5. NPTEL Reference :https://onlinecourses.nptel.ac.in/noc17_cs22/preview

| **24CSC382** | **Data Mining Lab** | **0 0 2 1** |

1) Working with objects using SQL 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, savepoint.

2) Constraints – Queries: Simple selection, projection and selection with conditions.
3) 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
5) queries and DML and sub queries.
6) Working with other schema objects: view, sequence, index, synonym, cluster, lock, BLOB, CLOB, nested
7) table, type.
8) PL/SQL programs, cursors, functions, procedures, packages, triggers, exception handling.
9) Front end tool: form creation, validation, trigger and report generation.
10) Mini Project.

24CSC383   **Machine Learning -Lab**   **0 0 2 1**

- Implementation of the FIND-Salgorithm for finding the most specific hypothesis based on a given set of training data samples.
- EM algorithm
- Implementation of the Locally weighted Regression algorithm
- Implementation of the Candidate-Elimination algorithm.
- Implementation of the K means algorithm
- Demonstration of the working of the decision tree based ID3 algorithm. Use an appropriate data set for
- building the decision tree and apply this knowledge to classify a new sample.
- Building an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets Back propagation Algorithm.
- Implementation of the naïve Bayesian classifier for a sample training data set.
- Implementation of the k-Nearest Neighbour algorithm to classify the data set.
- Implementation of the non-parametric Locally Weighted Regression algorithm in
- order to fit data points.

24CSC384   **Open Lab-II**   **0 0 2 1**

The students can choose any of the following, which is not studied in 24CSC381 Open Lab-I:

- JAVA Programming
- C++
- Web Design
- Algorithms.io
- Hadoop
- Cascading
- TensorFlow
- SAS (Statistical Software Suite)
- *Julia*

Evaluation: 60 marks for CA (weekly lab evaluation) + 40 marks for end semester

Semester 7

24MAT501   **Graph Analytics**   **3 0 2 4**

Review of Graphs: Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, shortest path algorithm. Eccentricity.

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. 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: Transport networks, Biological networks, ect.,

TEXTBOOKS

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

3. 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

5. Graph Algorithms in Neo4j

24CSC501   **Software Engineering**   **3 0 2 4**

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.

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.

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

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.

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.Self-Study:

Text Books: 1.Ian Sommerville, Software Engineering, Addison – Wesley
References:
1.Roger Pressman, Software Engineering A Practitioners Approach, McGraw Hill Publication
2.Rajib Mall, Fundamentals of Software Engineering, Prentice Hall of India
3.Ivar Jacobson, Object Oriented Software Engineering A use case Approach, Pearson

24CSC502   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.

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:

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.

24MAT502 **Basic Topology** **3 1 0 4**

Functions, Cartesian Products, Finite sets, Countable and Uncountable Sets, Infinite Sets .The Axiom of Choice, Well-ordered Sets, The Maximum Principle, Topological Spaces, Basis for a Topology.

The Order Topology, The Product Topology on $X \times Y$, The Subspace Topology.

Closed Sets and Limit Points, Continuous Functions, The Product Topology. Connected Spaces, Connected Subspaces of the Real Line, Components and Local Connectedness. Compact Spaces, Compact Subspaces of the Real Line, Limit point compactness, LocalCompactness.

Text Books:

1. J. Munkres, "Topology"; Prentice Hall, 2002, Second edition.

2. G.F.Simmons, "Introdution to Topology and Modern Analysis" McGraw Hill Education-2004.

3. S. Kumaresan, "Topology of Metric Spaces"; Narosa Publishing House, New Delhi, 2011Second Reprint.

4. J. Dugundji, " Topology" Allyn and Bacon, Boston-1966

24CSC503   **Deep Learning**   **3 0 2 4**

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

Semester 8

24CSC511   **Artificial Intelligence**   **3 0 2 4**

Introduction to AI. Future of Artificial Intelligence — Characteristics of Intelligent Agents– Typical Intelligent Agents — Problem Solving Approach to Typical AI problems.

Search Methods: Uninformed Search, Informed Search, Path Search vs. Local Search. Game Playing Through Search: Minimax and Alpha-Beta

Constraint Satisfaction. Inductive Learning. Decision Trees. Artificial Neural Networks Propositional & First Order Logic.
Architecture for Intelligent Agents — Agent communication — Negotiation and Bargaining —

Argumentation among Agents — Trust and Reputation in Multi-agent systems.
AI applications — Language Models — Information Retrieval- Information Extraction — Natural Language Processing — Machine Translation — Speech Recognition — Robot — Hardware — Perception — Planning — Moving.

Text Books:
1. Artificial Intelligence: A Modern Approach - The Intelligent Agent Book 3rd Ed. by S. Russell and P. Norvig, Prentice-Hall, 2010.
2. Vinod Chandra S S and Hareendran S, Artificial Intelligence and Machine Learning, first edition, PHI, 2022.
3. Principles of Artificial Intelligence – Nils J. Nilsson (Narosa Publishing House)
4. Introduction to Artificial Intelligence – Eugene Charnaik, Drew McDermott (Pearson Education Asia)

24CSC512   Parallel and Distributed Systems   3 0 2 4

Introduction – parallelism and goals, parallel computing models – RAM, PRAM , CTA. Reasoning about Performance – Introduction -Basic Concepts - Performance Loss - Parallel Structure - Measuring Performance. Shared memory architecture.

Parallel Programming: Task and Data Parallelism with examples –Comparison Programming with Threads - POSIX Threads- Thread Creation and Destruction. Mutual Exclusion- Synchronization - Safety and Performance Issues – Reduction – threads Inter process communication – internet protocols – multicast communication – MPI. Remote invocation:Remote procedure call – remote method invocation -

System models : physical models, architecture models, operating system support. Distributed file systems – introduction- time and global states – synchronization of physical clocks – coordination and agreements: Mutual exclusion, election, consensus.

Text Books

1. George Coulouris , Jean Dollimore , Tim Kindberg , Gordon BlairDISTRIBUTED SYSTEMS Concepts and Design Fifth Edition , Addison Wiley, 2012.
2. Calvin Lin ,Larry Snyder, Principles of Parallel Programming, Pearson, 2009 .
3. Bertil Schmidt, Jorge Gonzalez-Dominguez, Christian Hundt , Moritz Schlarb, Parallel Programming: Concepts and Practice 1st Edition, Morgan Kaufmann, 2017.

4. Ajay D. Kshemkalyani, MukeshSinghal , Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, first edition, 2008.

24CSC513   **Data Security**   **3 0 0 3**

Access control mechanisms in general computing systems; Authentication and authorization mechanisms- Passwords (Single vs Multifactor), Captcha, Single Sign-on- Oauth and Openid connect, Authentication Protocols (Kerberos, X.509).

Malwares and its protection mechanisms- Viruses, Worms, Trojans, Ransomware, Polymorphic malware, Antivirus, Firewall and Intrusion detection systems.

Networking Basics, Web, Email, and IP Security- SSL, TLS, WEP, SET, Blockchain, PGP, IPSEC.

Image Processing Basics, Digital Watermarking, Steganography and Visual Cryptography.

Database System Basics, Database Security- Database watermarking, Statistical inferencing in databases, Private information retrieval, Privacy in data publishing, SQL Injection, Spark Security.

Text book:

1. Mark Stamp, "Information Security: Principles and Practice", Wiley Publishing, 2nd edition, 2011
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", Tata McGraw-Hill Education Pvt. Ltd., 2nd edition, 2010

References:

1. Alfred Basta and Melissa Zgola, "Database Security", Cengage Learning India Pvt. Ltd., 1st edition, 2014.
2. Shivendra Shivani, Suneeta Agarwal and Jasjit S. Suri, "Handbook of Image-based Security Techniques", Taylor and Francis, 1st edition, 2018.
3. Michael Gertz, "Handbook of Database Security: Applications and Trends", Springer, 2008 edition.
4. Antony Lewis, "The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them", Mango Media, 2018.
5. Prabath Siriwardena, "Advanced API Security: Securing APIs with OAuth 2.0, OpenID Connect, JWS, and JWE", Apress, 1st edition, 2014.
6. Romeo Kienzler, "Mastering Apache Spark 2.x", Packt Publishing Limited; 2nd Revised edition, 2017.

24CSC514   **Reinforcement Learning**   **3 0 2 4**

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

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.

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.

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 Book:
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.

Semester 9

24CSC698   **Project –I**   **8 credits**

The students shall take a project in their ninth semester for eight credits. This project will be as an internship in either industries or academic institutions. A faculty member and a mentor from industries / academic institution will be assigned for each student for this Project-I. Students expected to submit a report on their works.

A review committee will review and evaluate all the projects.

Evaluation: Mid team review – 40 marks and End team review – 60 marks

Semester 10

24CSC699   **Project II – Dissertation**   **12**

The students shall take this project in their tenth semester for 12 credits. This can be the continuation of the Project-I. This project will be as an internship in either industries or academic institutions.   A faculty member and a mentor from industries / academic institution will be assigned for each student for this Project-II. Students expected to submit a detailed project report.

A review committee will review and evaluate all the projects.

Evaluation: Mid team review – 40 marks and End team review – 60 marks.

Elective Courses

24MAT531   **Advanced Algebra**   **3 0 0 3**

Cyclotomic Polynomial and Extensions of Fields.

Galois Theory: The Elements of Galois Theory, Group of Automorphisms and its fixed field, Galois Group, The Fundamental Theorem of Galois Theory, Solvable Groups, Solvability by Radicals.

Introduction to the Representation Theory. Linear Actions and Modules over group rings.

REFERENCES:

1. D.S. Dummit and R. M. Foote, 'Abstract Algebra', 2nd Ed., John Wiley, 2002.
2. John B. Fraleigh, 'A First Course in Abstract Algebra', Narosa Publishing House, 2003.
3. Joseph A. Gallian, 'Contemporary Abstract Algebra', Cengage Learning., 2013.
4. M.Artin, 'Algebra', Prentice Hall inc 1994.
5. Joseph Rotman,'Galois Theory', 2nd Ed., Springer, 2001

24MAT532   **Advanced Topology**

3 0 0 3

The Metric Topology, The Countability Axioms, The Separation Axioms. Normal Spaces. The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze Extension Theorem. The Tychonoff Theorem, Local Finiteness, The Nagata-Smirnov Metrization Theorem,Para-compactness, The Smirnov Metrization Theorem. Complete Metric Spaces, Compactness in Metric Spaces, Pointwise and Compact Convergence, Ascoli's Theorem, Baire Space. Homotopy of Paths, The Fundamental Group, Covering Spaces.

TEXT BOOKS:

1 J. Munkres, "Topology"; Prentice Hall, 2002, Second edition

2. S. Kumaresan, "Topology of Metric Spaces"; Narosa Publishing House, New Delhi, 2011Second Reprint.

3 .J. Dugundji, " Topology" Allyn and Bacon, Boston-1966.

4. Fred H. Croom, "Principles of Topology", Cengage Learning.

24MAT533   FUNCTIONAL ANALYSIS   3 0 0 3

Normed linear spaces, Banach spaces, Classical examples: $C[0,1], l_p, C, C_0, C_{00}, L^p[0,1]$, Continuity of Linear Operator and bounded linear operator, Quotient spaces
Finite dimensional normed spaces, Riesz lemma, (non) compactness of unit ball, Hahn Banach theorem and Its consequences.
Uniform Boundedness principle, Closed Graph Theorem, Bounded Inverse Theorem, Open Mapping Theorem, Banach Steinhauss Theorem
Bounded Linear Functionals, Dual space of classical spaces, Reflexivity of the Banach Space, Hilbert spaces, Projection theorem, Orthonormal basis, Bessel inequality, Parseval's equality
Seperable Hilbert spaces and Countable orthonormal basis, example of non seperable spaces, Uncountable orthonormal basis and definition of convergence of Fourier series – Riesz-Fisher's theorem, Riesz representation theorem

REFERENCE BOOKS:

1. Linear Analysis by Bela Bollobas, Cambridge University Press, 1999
2. Functional Analysis by Balmohan V Limaye, New Age International Publishers, Third Ed, Reprint2014.
3. Introduction to Topology and Modern Analysis by G. F. Simmons, McGraw Hill Education, 2004
4. Thamban Nair, Functional Analysis: A First Course, PHI, 2001.

24MAT534   Operator Theory   3 0 0 3

Compact operators on Hilbert Spaces. (a) Fredholm Theory (b) Index, C∗- algebras - noncommutative states and representations, Gelfand-Neumark representation theorem, Von- Neumann algebras; projections, double commutant theorem, L∞ functional calculus, Toeplitzoperators.

 REFERENCE BOOKS:

1. W. Arveson, "An invitation to C*-algebras", Graduate Texts in Mathematics,
No. 39.Springer-Verlag, 1976.

2. N. Dunford and J. T. Schwartz, "Linear operators. Part II: Spectral theory. Self adjointoperators in Hilbert space", Interscience Publishers John Wiley i& Sons 1963.

3. R. V. Kadison and J. R. Ringrose, "Fundamentals of the theory of operator algebras. Vol.Elementary theory", Pure and Applied Mathematics, 100, Academic Press, Inc., 1983.

24MAT535   MEASURE THEORY   3 0 0 3

Measure on the Real Line: Lebesgue Outer Measure - Measurable Sets – Regularity - Measurable Functions - Borel and Lebesgue Measurability

Integration of Functions of a Real Variable: Integration of Non-Negative Functions - The General Integral - Integration of Series - Riemann and Lebesgue Integrals.

Abstract Measure Spaces: Measures and Outer Measures - Extension of a Measure -Uniqueness of the Extension - Completion of a Measure - Measure Spaces - Integration with Respect to a Measure.

Inequalities and the L^p Spaces: The L^p Spaces - Convex Functions - Jensen's Inequality - The Inequalities of Holder and Minkowski - Completeness of $L^p(\mu)$.

Signed Measures and their Derivatives: Signed Measures and the Decomposition - The Jordan Decomposition - The Radon-Nikodym Theorem - Some Applications of the Radon-Nikodym Theorem.

Measure Theory TEXTBOOK: and Integration by G.de Barra. First Edition. New Age International Publishers, Reprint 2000.   Reference Book:

1. Real Analysis by H.L. Royden and P.M.Fitzpatrick. Fourth Edition. Pearson Education Asia Limited, 2010.

2. Elias M. Stein & Rami Shakarchi, Real Analysis Measure Theory, Integration, and Hilbert Spaces (Princeton Lectures in Analysis), Princeton university press, 2007.

24MAT536   Theory of Ordinary Differential Equations   3 0 0 3

Linear differential equations: Introduction, initial value problems, the wronskian and linear independence, reduction of order of a homogeneous equation, non-homogeneous equation. **Existence - Uniqueness of Solutions to First Order Equations:** Equations with variable separated, Exact equations, the method of successive approximations, Lipschitz condition, Convergence of successive approximations, Non–local existence of solutions, Approximations to, and uniqueness, of solutions. Systems of first order equations, Existence and uniqueness theorem, fundamental matrix, nonhomogenous linear systems, linear systems with constant coefficients. Complex n-dimensional space, Systems as vector equations, Existence and

uniqueness of solutions to systems, Existence and Uniqueness of linear systems, Equations of order n.

Nonlinear equations: Autonomous Systems, The Phase plane and its phenomena, Types of critical points. Stability, critical points and stability for linear systems, Stability by Liapunov's Direct method, stability by eigen values, Simple critical points of nonlinear systems. Nonlinear mechanics, Conservative systems, Periodic solutions, The Poincaré–Bendixson theorem. Oscillations and the Sturm Separation theorem, The Sturm comparison theorem.

TEXT BOOKS:
1.George F. Simmons and John S Robertson, Differential equations with applications and historical notes, Tata McGraw Hill Education Private Limited, Second Edition, 2003.
2. E.A. Coddington, An introduction to ordinary differential equations, PHI learning, 1999.
3 .S.G.Deo,V.Lakshmikantham and V Raghavendra, Text book of Ordinary differential equations, McGraw Hill Education Private Limited, second edition, 2013.

22MAT537   PARTIAL DIFFERENTIAL EQUATIONS   3 0 0 3

Geometrical interpretation of a first-order pde, method of characteristics and general solutions, Monge cone, Lagrange's equations, canonical forms of first-order linear equations, method of separation of variables.
Second-order equations in two independent variables, canonical forms, equations with constant coefficients, general solutions.
The Cauchy problem, the Cauchy-Kowalewskaya theorem, homogeneous wave equations, the D'Alembert solution of wave equation, initial boundary-value problems, equations with nonhomogeneous boundary conditions, vibration of finite string with fixed ends,.(review) nonhomogeneous wave equations.
Basic concepts, types of boundary-value problems, maximum and minimum principles, uniqueness and continuity theorems. Dirichlet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, Dirichlet problem for a rectangle, Dirichlet problem involving the Poisson equation, the Neumann problem for a rectangle.
Derivation of the heat equation and solutions of the standard initial and boundary value problems, uniqueness and the maximum principle, time-independent boundary conditions, time-dependent boundary conditions.

TEXT BOOKS:
1. Tyn Myint-U, Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkhauser,Boston, Fourth Edition, 2007.
2. D. Bleecker, G. Csordas, Basic Partial Differential Equations, Van Nostrand Reinhold, New York, 1992.

References:

1. L.C. Evans, Partial Differrential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, Providence, 1998.

2. I.N. Sneddon, Elements of partial differential equations, McGraw Hill, New York, 1986.
3. E. Zauderer, Partial Differrential Equations of Applied Mathematics, John Wileys & Sons, New York, 2nd edition, 1989.
4. E. C. Zachmanoglou and D. W. Thoe, Introduction to Partial Differential Equations with Applications, Dover Publication, New York, 1986.

24MAT538   COMMUTATIVE ALGEBRA   3 0 0 3

1. Rings and ideals, modules and operations on them (tensor product, Hom, direct sum and product). Rings and modules of Fractions, primary decomposition. Integral dependence and Valuations, Chain Conditions.
2. Noetherian Rings and Artin Rings.
3. Discrete valuation Rings and Dedekind Domains, Dimension theory.

TEXT BOOKS / References
1. Atiyah-Macdonald, Commutative Algebra, Westview Press, 1994.
2. Zariski and Samuel, Commutative Algebra I, II , Springer, 1991.
3. Eisenbud, Commutative Algebra with a View Towards Algebraic Geometry, Springer, 1995.
4. Bourbaki, Commutative Algebra, Springer, 1989.

24MAT539   FIXED POINT THEORY   3 0 0 3

Contraction Principle, and its variants and applications. Fixed points of non-expansive maand set valued maps, Brouwer-Schauder fixed point theorems. Ky Fan Best Approximation Theorem, Principle and Applications of KKM - maps, theirvariants and applications.Fixed Point Theorems in partially ordered spaces and other abstract spaces.

Application of fixed point theory to Game theory and Mathematical Economics.

 TEXT BOOKS / / REFERENCE BOOKS:

1. M.A. Khamsi and W.A. Kirk, An Introduction to Metric Spaces and Fixed PointTheory, Wiley - Inter Sci. (2001).
2. Sankatha Singh, Bruce Watson and Pramila Srivastava, Fixed Point Theory and BestApproximation: The KKM - map Principle, Kluwer Academic Publishers, 1997.

1.Kim C. Border, Fixed Point Theorems with Applications to Economics and Game Theory,Cambridge University Press, 1985.

24MAT540   **FLUID DYNAMICS**   **3 0 0 3**

Review of Conservation equations for mass, momentum and energy; coordinate systems;Eulerian and Lagrangian approach, Conservative and non-conservative forms of the equations, rotating co-ordinates.

Classification of system of PDEs: parabolic elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods; Review of Finite Difference Method, Introduction to integral method, method of weighted residuals, finite elements finite volume method & least square method.

Numerical Grid Generation: Basic ideas, transformation and mapping, unstructured grid generation, moving grids, unmatched meshes. Finite Volume Method: Basic methodology, finite volume discretization, approximation of surface and volume integrals, interpolation methods - central, upwind and hybrid formulations and comparison for convection-diffusion problem; Basic computational methods for compressible flows. Advanced Finite Volume methods: FV discretization in two and three dimensions, SIMPLE algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modelling, illustrative flow computations.

 TEXT BOOKS / REFERENCE BOOKS:
1.Anderson D A, Tannehill J C, and Pletcher R H, Computational Fluid Mechanics and Heat Transfer, 2nd edition, Taylor & Francis, 1997.
2.Ferziger, J. H. and Peric, M., Computational Methods for Fluid Dynamics, 3rd edition, Springer. 2003.

24MAT541   **FINITE ELEMENT METHODS**   **3 0 0 3**

Finite Element Method: Variational formulation - Rayleigh-Ritz minimization - weighted residuals - Galerkin method applied to boundary value problems.Global and local finite element models in one dimension - derivation of finite element equation.Finite element interpolation - polynomial elements in one dimension, two dimensional elements, natural coordinates, triangular elements, rectangular elements, Lagrangian and Hermite elements for rectangular elements - global interpolation functions.Local and global forms of finite element equations -

boundary conditions - methods of solution for a steady state problem - Newton-Raphson continuation. One dimensional heat and wave equations.

TEXT AND REFERENCE BOOKS

1. J.N .Reddy, An Introduction to the Finite Element Method, McGraw Hill, NY.

2. Chung, Finite Element Analysis in Fluid Dynamics, McGraw Hill Inc.

24MAT542   Advanced Graph Theory   3 0 0 3

Review of Graphs: Graphs and Sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, shortest path algorithm.

Euler and Hamilton Graphs: Euler graphs, Euler's theorem. Fleury's algorithm for Eulerian trails. Necessary / sufficient conditions for the existence of Hamilton cycles, Chinese-postman problem, approximate solutions of traveling salesman problem.

Matching: Matchings, maximal matchings. Coverings and minimal coverings. Berge's theorem,Hall's theorem, Tutte's perfect matching theorem, Job assignment problem.

Coverings, Independent Sets and Cliques; Basic Relations. Graph dominations and coverings.

Colorings: Vertex colorings, greedy algorithm and its consequences, Brooks' theorem. Chromaticpolynomials. Edge-colorings, Vizing theorem on edge-colorings.

Planar graphs: Euler formula. Crossing number Kuratowaski's Characterization,   Planarity testing algorithm. Spear Embedding. Dual graphs Adjacency matrix of a graph and its eigenvalues, Spectral radius of graphs, Regular graphs and Line graphs, Strongly regular graphs, Cycles and Cuts, Laplacian matrix of a graph, Algebraic connectivity, Laplacian spectral radius of graphs.

TEXT BOOKS

1. J.A. Bondy and U.S.R. Murty, Graph Theory and Applications, Springer, 2008.
2. D.B. West, Introduction to Graph Theory, P.H.I. 2010.

REFERENCES BOOKS

1. Frank Harary, Graph Theory, New York Academy of Sciences, 1979.
2. Balakrishnan and Ranganathan, Graph Theory, springer.
3. Russel Merris, Graph Theory, John Wiley, 2011.
4. C. Godsil, G. Royle, "Algebraic Graph Theory", Graduate Texts in Mathematics 207,Springer-Verlag, 2001.
5. R. B. Bapat, "Graphs and Matrices", Universitext, Springer, Hindustan Book Agency, NewDelhi, 2010.

24MAT543   **Representation Theory**   **3 0 0 3**

Basic objects and notions of representation theory: Associative algebras. Algebras definedby generators and relations. Group algebras. Quivers and path algebras. Lie algebras and enveloping algebras. Representations. Irreducible and indecomposable representations. Schur's lemma. Representations of sl(2).

Basic general results of representation theory. The density theorem. Representations of finite dimensional algebras. Semisimple algebras. Characters of representations. Jordan-Holder and Krull-Schmidt theorems. Extensions of representations.

Representations of finite groups, basic results. Maschke's theorem. Sum of squares formula. Duals and tensor products of representations. Orthogonality of characters. Orthogonality of matrix elements. Character tables, examples. Unitary representations. Computation of tensor product and restriction multiplicities from character tables. Applications of representation theory of finite groups.

Representations of finite groups, further results: Frobenius-Schur indicator. Frobenius determinant. Algebraic integers and Frobenius divisibility theorem. Applications to the theory of finite groups: Burnside's theorem. Induced representations and their characters (Mackey formula). Frobenius reciprocity. Representations of GL(2; Fq). Representations of the symmetric group and the general linear group. Schur-Weyl duality. The fundamentaltheorem of invariant theory.

Representations of quivers. Indecomposable representations of quivers of type A1, A2, A3,D4. The triple of subspaces problem. Gabriel's theorem. Proof of Gabriel's theorem: Simply laced root systems, reflection functors.

24MAT544   **Coding Theory**   **3 0 0 3**

Information Theory: Entropy, Huffman coding, Shannon-Fano coding, entropy of Markov process, channel and mutual information, channel capacity; Error correcting codes: Maximum likelihood decoding, nearest neighbour decoding, linear codes, generator matrix and parity-check matrix, Hamming bound, Gilbert-Varshamov bound, binary Hamming codes, Plotkin bound, nonlinear codes, Reed-Muller codes, Cyclic codes, BCH codes, Reed-Solomon codes, Algebraic codes.

Reference Books:

1. R. W. Hamming, "Coding and Information Theory", Prentice-Hall, 1986.
2. N. J. A. Sloane, F. J. MacWilliams, "Theory of Error Correcting Codes", North-Holland Mathematical Library 16, North-Holland, 2007.
3. S. Ling, C. Xing, "Coding Theory: A First Course", Cambridge University Press, 2004.
4. V. Pless, "Introduction to the Theory of Error-Correcting Codes", Wiley-Interscience Publication, John Wiley & Sons, 1998.
5. S. Lin, "An Introduction to Error-Correcting Codes", Prentice-Hall, 1970.

24MAT545 Statistical Pattern Recognition 3 0 0 3

Introduction and Bayesian Decision Theory– Pattern recognition systems – the design cycle – learning and adaptation – Bayesian decision theory – continuous features – Minimum error rate classification – discriminant functions and decision surfaces – the normal density based discriminant functions.

Maximum likelihood estimation – Bayesian estimation - Bayesian parameter estimation – Gaussian case and general theory – problems of dimensionality – components analysis and discriminants – hidden Markov models.

Nonparametric techniques and linear discriminant functions- density estimation – Parzen windows – nearest neighbourhood estimation – rules and metrics – linear discriminant functions and decision surfaces – generalized linear discriminant functions – two-category linearly separable case – minimizing the perception criterion function.

Nonmetric methods and algorithm-independent machine learning- decision trees – CARTmethods – algorithm-independent machine learning – lack of inherent superiority of any classifier – bias and

variance for regression and classification – resampling or estimating statistics – estimating and comparing classifiers.

Unsupervised learning and clustering – mixture densities and identifiability – maximum likelihood estimates – application to normal mixtures – unsupervised Bayesian learning – data description and clustering – criterion functions for clustering – hierarchical clustering – component analysis – low-dimensional representations and multi-dimensional scaling.

TEXT BOOKS / References:

1.Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", Second Edition, 2003, John wily & sons.

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

3.Nilsson N J, "The Quest for Artificial Intelligence", Cambridge University Press, 2009.

24MAT546 WAVELETS 3 0 0 3

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

Construction of Wavelets on Z_N, The First Stage Construction of Wavelets on Z_N, The Iteration Step.
Examples and Applications, $l2(Z)$,

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.

$L_2(R)$ and Approximate Identities, The Fourier Transform on R, Multiresolution Analysis and Wavelets, Construction of Multiresolution Analyses, Wavelets with Compact Support and Their Computation.

References:

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

2.Daubechis, Ten Lectures on Wavelets, SIAM, 1992.
   Mallat, S. A Wavelet Tour of Signal Processing, Elsevier, 2008

24MAT547 Statistical Quality Control 3 0 0 3

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

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 curves of control charts, 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 - Design for Six Sigma - Lean Sigma – Statistical tools for Six Sigma.

Acceptance sampling for attributes, single sampling, double sampling, multiple sampling and sequential sampling plans, rectifying inspection plans, measuring performance of the sampling plans- OC, AOQ, ASN, ATI curves.

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, orthogonal arrays and parameter Design.

TEXT AND REFERENCE BOOKS

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

24MAT548   **Time Series Analysis**   **3 0 0 3**

Introduction: Examples of time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components. 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. Modeling and Forecasting with ARMA Processes: Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection. 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. Forecasting Techniques: The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm. Estimation of time series models.

Text Books:

1.Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.

1. 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 andControl,3rdEdition,PrenticeHall,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. Galit Shmueli and Kenneth C. Lichtendahl Jr (2016). Practical Time Series Forecasting with R: A Hands-
5. On Guide, 2nd Edition, Axelrod Schnall Publishers.

24MAT549   COMPUTATIONAL GEOMETRY   3 0 0 3

Convex hulls: construction in 2d and 3d, lower bounds; Triangulations: polygon triangulations, representations, point-set triangulations, planar graphs; Voronoi diagrams: construction and applications, variants; Delaunay triangulations: divide-and-conquer, flip and incremental algorithms, duality of Voronoi diagrams, min-max angle properties; Geometric searching: point location, fractional cascading, linear programming with prune and search, finger trees, concatenable queues, segment trees, interval trees; Visibility: algorithms for weak and strong visibility, visibility with reflections, art-gallery problems; Arrangements of lines: arrangements of hyperplanes, zone theorems, many-faces complexity and algorithms; Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, k-sets, polytopes and hierarchies, polytopes and linear programming in d-dimensions, complexity of the union of convex sets, simply connected sets and visible regions; Sweep techniques: plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements; Randomization in computational geometry: algorithms, techniques for counting; Robust geometric computing; Applications of computational geometry.

TEXT BOOKS /References

1.Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational
2. Geometry: Algorithms and Applications, Springer.

3.F. P. Preparata and Michael I. Shamos, Computational Geometry: An Introduction, Springer.
4.Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.
5. Lecture Notes by David Mount.

24MAT550   QUEUING THEORY AND INVENTORY CONTROL   3 0 0 3

Inventory concept – Components of Inventory model.
Deterministic Continuous Review model - Deterministic Periodic Review model.
The classical EOQ – Non zero lead time – EOQ with and without shortages.
Deterministic Multiechelon Inventory models for supply chain management.
A stochastic continuous review model – A stochastic single period model for perishable products.

TEXT BOOKS
1. F S Hillier and Gerald J Lieberman, Introduction to Operations research, 8th edition, McGraw Hill.

2. Ravindran , Phillips and Solberg, Operations research Principles and Practice, 2nd Edition, John Wiley & Sons.

24MAT551   Nonlinear Dynamics and Chaos   3 0 0 3

Flows on the line-A Geometric Way of Thinking, Fixed Points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness, Solving Equations on the Computer. Bifurcations-Saddle-Node Bifurcation, Transcritical Bifurcation, Pitchfork Bifurcation.

Linear Systems-Definitions and Examples, Classification of Linear Systems. Phase Plane-Phase Portraits, Fixed Points and Linearization, Index Theory. Limit Cycles- Ruling Out Closed Orbits, Poincare-Bendixson Theorem, Lienard Systems, Relaxation Oscillators, Weakly Nonlinear Oscillators. Bifurcations Saddle-Node, Transcritical, and Pitchfork Bifurcations, Hopf-Bifurcations. Oscillating Chemical Reactions, Global Bifurcations of Cycles, Hysteresis in the Driven Pendulum and Josephson Junction, Coupled Oscillators and Quasiperiodicity, Poincare Maps.

Lorenz Equations-Simple Properties of the Lorenz Equations, Chaos on a Strange Attractor, Lorenz Map, Exploring Parameter Space. One-Dimensional aps- Fixed Points and Cobwebs, Logistic Map: Logistic Map: Analysis, Periodic Windows, Liapunov Exponent, Universality and Renormalization.

Text / Reference Books:

1.Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering by Steven H. Strogatz (CRC Press; 2nd Edition), 2015.
2.Chaos: An Introduction to Dynamical systems by K. T. Alligood, T. D. Sauer, J. A. Yorke (Springer Verlag), 1996

24CSC531   Soft Computing   2 0 2 3

Artificial Intelligence (*AI*): A Brief review – Pitfalls of Traditional *AI*–Why computational intelligence (*CI*)

 – Concepts of *CI* – Importance of tolerance of imprecision and uncertainty– Constituent techniques of *CI*– overview of Artificial Neural Networks, Fuzzy Logic, Evolutionary Computation.

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 fuzzysystems. Fuzzy control systems – Aircraft landing control problems.

Evolutionary computation: Introduction – Constituent algorithms - Using Genetic Algorithm for solving simple optimization problems. Swarm intelligence algorithms – Overview of other bio-inspired algorithms – Over view of Hybrid approaches (neural networks, fuzzy logics, genetic algorithm etc).

Text Books:
1. Kumar S. 'Neural Networks – A classroom approach', TMH, 20014.
2. Ross T J 'Fuzzy Logic with Engineering Applications', TMH, 2002.

3. 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 Verlat, 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.

24CSC532   Cryptography   2 0 2 3

Stream ciphers: Pseudo-random generators, Attacks on the one time pad, Linear generators, Cryptanalysis of linear congruential generators, The subset sum generator.

Block ciphers: Pseudorandom functions and permutations (PRFs and PRPs), PRP under chosen plaintext attack and chosen ciphertext attack, Case study: *DES, AES, modes of operation*.

Message integrity: Cryptographic hash functions, message authentication code, CBC MAC and its security, Cryptographic hash functions based MACs, Authenticated Encryption-Authenticated encryption ciphers from generic composition.

Public key encryption: RSA, Rabin, Knapsack cryptosystems, Diffie-Hellman key exchange protocol, ElGamal encryption, Elliptic curve cryptography.

Digital signatures: RSA, ElGamal and Rabin's signature schemes, blind signatures.

Entity authentication: Passwords, challenge-response algorithms, zero-knowledge protocols.

Network security: Certification, public-key infra-structure (PKI), secure socket layer (SSL), Kerberos.

TEXT BOOKS/REFERENCES:

1. A. 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.
3. Abhijit Das and Veni Madhavan C. E., Public-Key Cryptography: Theory and Practice, Pearson Education India, 2009.
4. Stinson, Douglas R. Cryptography: theory and practice. Chapman and Hall/CRC, 2005.
5. Dan Boneh and Victor Shoup, A Graduate Course in Applied Cryptography,V4, 2017

24CSC533   BUSINESS ANALYTICS   2 0 2 3

INTRODUCTION   TO   BUSINESS   ANALYTICS:
Business Analytics - Terminologies, Process, Importance, Relationship with

Organisational Decision Making, Analytics in Decision Making, BA for Competitive Advantage.

MANAGEING RESOURCES FOR BUSINESS ANALYTICS: Managing BA Personnel, Data and Technology. Organisational Structures aligning BA. Managing Information policy, data quality and change in BA.

DESCRIPTIVEANALYTICS:
Introduction to Descriptive analytics – Visualising, and Exploring Data - Descriptive Statistics - Sampling and Estimation - Probability Distribution for Descriptive Analytics –

Analysis of Descriptive analytics.

PREDICTIVEANALYTICS:
Introduction to Predictive analytics - Logic and Data Driven Models - Predictive Analysis Modeling and procedure - Data Mining for Predictive analytics. Analysis of Predictive analytics.

PRESCRITIVEANALYTICS:
Introduction to Prescriptive analytics - Prescriptive Modeling - Non Linear Optimisation - Demonstrating Business Performance Improvement.

CaseStudies:
Text:
1. Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, " Business Analytics Principles, Concepts, and Applications - What, Why, and How" , PearsonEd2014
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.

24CSC534 DEEP LEARNING FOR IMAGE PROCESSING 2 0 2 3

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 BOOKS / References:

1.Gonzalez R C and Woods R E, "Digital Image Processing", Third Edition, Pearson Education, 2009.
2.Pratt W K, "Digital Image Processing", Fourth Edition, John Wiley & Sons, 2007.
3.Castleman K R, "Digital Image Processing", Prentice Hall, 1996.
2.Gonzalez, Woods and Eddins, "Digital Image Processing Using MATLAB", Prentice Hall, 2004.
3.Russ J C, "The Image Processing Handbook", CRC Press, 2007.

24CSC535   Predictive Analytics   2 0 2 3

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. 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.
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.
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 / References:

1. Eric Siegel, Predictive Analytics, Wiley, 2021
2. Jeffrey T. Prince and Amarnath Bose, A Predictive Analytics for Business Strategy - Reasoning from Data to Actionable Knowledge, Mc Graw Hill, 2020.
3. David L Olson, Data Mining Models, Business Expert Press, 2016

24CSC536   Mining of Massive Datasets   2 0 2 3

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 Books:
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; 4 edition , 2015.

24CSC537   Data Compression   2 0 2 3

Information Theory Foundation: Entropy, its properties, conditional entropy, mutual information, Types of codes, Krafts McMillan Inequality theorem, Source coding theorem.Introduction to Compression Techniques: Introduction, Types of compression - Lossy, lossless. Performance measures, Modeling, Coding. Text Compression: Huffmann –

static and dynamic, application in text compression, Shannon Fano Elias Coding, Arithmetic coding, Dictionary based coding-static, adaptive, UNIX compress.

Scalar and Vector Quantization: Scalar Quantization – Introduction, Uniform and Adaptive quantization. Vector Quantization- Introduction, Advantages, LBG, Tree 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

Image Compression: Distortion criteria- The human visual system, Transform coding- DCT, JPEG, JBIG II, GIF, Wavelet based compression- wavelets, the scaling function, Haar Transforms, JPEG-2000. Video Compression: Motion Estimation and Compensation- Full search and Fast search algorithms,
H.261, MPEG-1, MPEG-2, MPEG-4, MPEG -7.

TEXT BOOKS:
1. Sayood and Khalid, "Introduction to Data Compression", Third Edition, Morgan Kaufmann, 2006.
2. Richardson I E G, "Video Codec Design: Developing Image and Video Compression Techniques",JohnWiley&Sons,2002.
3. Salomon D, "Data Compression: The Complete Reference", Fourth Edition, Springer, 2007.
4. Gersho A and Kluwer R M G, "Vector Quantization and Signal Compression", Academic Press,1992.

24CSC538   Introduction to Embedded Systems   2 0 2 3

Architecture of Microprocessors: General definitions of computers, micro-processors, micro controllers and digital signal processors.
Overview of Microcontrollers- Introduction to 8051 microcontroller, General Architecture of a MCU and more specific to 8051 family MCUs, Pin diagram of 8051 MCU and various control signals, Various addressing modes of 8051, 8051 Instruction Set and Programming - Data Movement, Arithmetic & Logical, Control instructions with example programs, 8051 Interfacing with peripherals - Simple IO devices and sensor devices interfacing with 8051 MCU, Timer / counter modules and interrupts in 8051, RS232 based serial Communication using 8051
ARM Architecture: RISC Machine, Architectural Inheritance, Programmers model. ARM Organization and Implementation. 3 Stage pipeline, 5 Stage pipeline, ARM Instruction execution,ARM Implementation, Co-processor interface, ARM Assembly language Programming, Data processing instructions, Data Transfer Instructions, Control flow instructions, Architectural support for high level programming, Thumb Instruction

set. Interrupt structure of 8086 and ARM: Vector interrupt table, Interrupt service routines. Introduction to DOS and BIOS Interrupts for 8086. Asynchronous and Synchronous data transfer schemes, ARM memory interface, AMBA interface, A/D Converters, PWM, timer / counter, UART and its interfacing – Application development using Keil IDE.

TEXT BOOKS
1. Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay - 8051 Microcontroller and Embedded Systems, The, 2nd Edition - 2006 – pearson
2.Steve Furber "ARM System on chip Architecture" , Second edition, Addidon Wesley, 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
3) Arnold S. Berger, "Embedded System Design", CMP Books, USA 2002.
4) Michael Barr, "Programming Embedded Systems with C and GNU‖, O Reilly, 2003.

24CSC539   INFORMATION RETRIEVAL   2 0 2 3

Boolean Retrieval – The term vocabulary and postings lists – Dictionaries and tolerant retrieval – Index construction – Index compression – Scoring, term weighting and the vector space model – Evaluation in Information retrieval.
Relevance feedback and query expansion – XML retrieval – Probabilistic information retrieval – Text classification – Vector space classification – Clustering – Matrix decomposition and latent semantic indexing.
     Web search basics – Web crawling and indexes – Link analysis.

TEXT BOOK:
Manning C D., Raghavan Pand Schutze H., "Introduction to Information Retrieval", Cambridge University Press, 2008.

REFERENCES:
1. R.Baeza-Yates and B. RibeiroNeto, "Modern Information Retrieval: The Concepts and Technology behind Search", Second Edition, Addison Wesley, 2011
2. David A.Grossman and OphirFrieder,"Information Retrieval: Algorithms and Heuristics", Second Edition, Springer 2004.

Online Social Networks (OSNs):

Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data. Techniques to study different aspects of OSNs -- Follower-followee dynamics, link farming, spam detection, hashtag popularity and prediction, linguistic styles of tweets. Case Study: An Analysis of Demographic and Behaviour Trends using Social Media: Facebook, Twitter and Instagram

Fundamentals of Social Data Analytics:

Introduction - Working with Social Media Data, Topic Models, Modelling social interactions on the Web – Agent Based Simulations, Random Walks and variants, Case Study: Social Network Influence on Mode Choice and Carpooling during Special Events: The Case of Purdue Game Day

Applied Social Data Analytics:

Application of Topic models, Information Diffusion, Opinions and Sentiments - Mining, Analysis and Summarization, Case Study: Sentiment Analysis on a set of Movie Reviews using Deep Learning techniques, Recommendation Systems, Language dynamics and influence in online communities, Community identification, link prediction and topical search in social networks, Case Study: The Interplay of Identity and Social Network: A Methodological and Empirical Study

Text and Reference books:

1. Cioffi-Revilla, Claudio. Introduction to Computational Social Science, Springer, 2014.
2. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013.
3. Robert Hanneman and Mark Riddle. Introduction to social network methods. Online Text Book, 2005.
4. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013.
5. Claudio Castellano, Santo Fortunato, and Vittorio Loreto, Statistical physics of social dynamics, Rev. Mod. Phys. 81, 591, 11 May 2009.
6. S. Fortunato and C. Castellano, Word of mouth and universal voting behaviour in proportional elections, Phys. Rev. Lett. 99, (2007).
7. Douglas D. Heckathorn, The Dynamics and Dilemmas of Collective Action, American Sociological Review (1996).
8. Michael W. Macy and Robert Willer, From factors to actors: Computational Sociology and Agent-Based Modeling, Annual Review of Sociology Vol. 28: 143-166 (2002).
9. Nilanjan Dey Samarjeet Borah Rosalina Babo Amira Ashour, Social Network Analytics - Computational Research Methods and Techniques, First Edition, eBook ISBN: 9780128156414, Paperback ISBN: 9780128154588, Imprint: Academic Press, Published Date: 23rd November 2018

24CSC541   **Big Data Storage and Analysis**   **2 0 2 3**

Introduction: Scaling with Traditional Databases - NoSQL need - First Princples – Desired Properties- Lambda Architectures. Batch Layer- Big data model – properties – fact based modeling – graph schemas – Apache Thrift,

Data Storage on Batch Layers – Requirements- Solutions- Distributed File Systems and Partitioning- Hadoop basics, Computing on Batch Layer- Algorithms-Scalability-MapReduce, Batch Layer Architecture and Algorithms – Design Overview and Workflow, Ingesting New Data, Normalization.

Serving Layer- Performance Metrics, Requirements and Design, ElephantDB. Speed Layer- Realtime Views, Cassandra basics, Query and Stream Processing , Apache Storm

TEXT BOOK:

Nathan Marz, James Warren, "Big Data: Principles and best practices of scalable real-time data systems", Manning Publications 2015.

    REFERENCES:

1. Tom White, "Hadoop – The Definitive Guide", O′Reilly; 3 edition (12 June 2012)

Randy Abernethy, "Programmer's Guide to Apache Thrift", Manning Publications, 2019

https://thrift.apache.org/

2. Jeff Carpenter, Eben Hewitt, "Cassandra: The Definitive Guide: Distributed Data at Web Scale", 2nd Edition, O'Reilly, 2016

3.Ankit Jain, "Mastering Apache Storm", Packt Publishing, 2017, https://www.elephantsql.com.

24CSC542   **Full Stack Development**   **2 0 2 3**

The main objective of full stack engineer is to keep every part of the system running smoothly. A Full Stack Developer can performs tasks ranging from resizing an image or text in a webpage to patching the kernel.

1 : All-in-One JavaScript Development Suite

- Fundamentals of JavaScript
- JavaScript for Beginning Web Developers
- JavaScript for Absolute Beginners
- Fundamentals of jQuery
- Fundamentals of Ajax Development
- Create a node.js Real Time Chat Application
- Advanced JavaScript

2 : All-In-One HTML/HTML5 And CSS/CSS3 Suite

- All-In-One HTML/HTML5 And CSS/CSS3 Suite

- Applying Designs to WireFrames with HTML5 and CSS3
- Build Your Own HTML5 Video Player
- Building Responsive Websites with HTML5 and CSS3
- HTML5 and CSS3 Site Design
- HTML5 Mobile Game Development by Example - Educational Game
- HTML5 Mobile Game Development by Example -Veggies vs Zombies
- Make HTML5 Games with No Coding Required
- Understanding HTML5 Input Types
- Website Wireframing with HTML5 and CSS3

3 : Node.Js Training

- Introduction and Foundation
- Node Projects
- Working with shrink-wrap to lock the node modules versions
- Working with asynchronous programming
- Building a HTTP Server with Node.JS using HTTP APIs
- File System
- Buffers, Streams, and Events
- Multi-Processing in NodeJS
- ExpressJS
- Express JS with MongoDB and Sqlite
- io, The Front-end, and A Chat App
- Introduction to Task Managers with unit testing

4 : Angular Training

- What is a SPA? What is Angular?
- Preparing for TypeScript
- Angular-4 new features
- Building with A4 Components
- Bootstrap Scaffolding
- Angular 4 Binding and Events
- Dependency Injection and services
- Directives
- Pipes
- Forms
- HTTP, Promises, and Observables
- Testing

24CSC543   **CLOUD COMPUTING**   **2   0   2   3**

Cloud Computing Overview: Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self- service, Broad network access, Location independent

resource pooling ,Rapid elasticity, Measured service, Comparing cloud providers with traditional   IT   service   providers,   Roots   of   cloud   computing. Cloud Insights: Architectural influences – High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability ,simplicity ,vendors ,security, Limitations – Sensitive information - Application development- security level of third   party   -   security   benefits,   Regularity   issues: Government   policies. Cloud Architecture: Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption. Cloud deployment model: Public clouds – Private clouds – Community clouds -   Hybrid   clouds   -   Advantages   of   Cloud   computing. Cloud Simulators: CloudSim and GreenCloud: Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to GreenCloud. Module-V: Introduction to VMWare Simulator Basics of VMWare, advantages of VMware virtualization, using Vmware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

TEXT BOOKS

1. Cloud computing a practical approach - Anthony T.Velte , Toby J. Velte Robert Elsenpeter, TATAMcGraw-Hill,NewDelhi2010.
2. Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online - Michael Miller - Que 2008.

References:
1. Cloud computing for dummies- Judith Hurwitz , Robin Bloor , Marcia Kaufman ,Fern Halper,WileyPublishing,Inc,2010.
2. Cloud Computing (Principles and Paradigms), Edited by Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, Inc. 2011.

24CSC544   **Data Wrangling**   **2   0   2   3**

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 Clean up-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.
REFERENCE   BOOKS
2. Dr. Tirthajyoti Sarkar, Shubhadeep," Data Wrangling with Python: Creating actionable data fromrawsources",PacktPublishingLtd,2019.
3.Stefanie Molin," Hands-On Data Analysis with Pandas", Packt Publishing Ltd,2019
4. Allan Visochek," Practical Data Wrangling", Packt Publishing Ltd,2017.

24CSC545   Parallel and Distributed Systems   2 0 2 3

Introduction – parallelism and goals, parallel computing models – RAM, PRAM , CTA. Reasoning about Performance – Introduction -Basic Concepts - Performance Loss - Parallel Structure - Measuring Performance. Shared memory architecture.

Parallel Programming: Task and Data Parallelism with examples –Comparison Programming with Threads - POSIX Threads- Thread Creation and Destruction. Mutual Exclusion- Synchronization - Safety and Performance Issues – Reduction – threads Inter process communication – internet

protocols – multicast communication – MPI. Remote invocation:Remote procedure call – remote method invocation -

System models : physical models, architecture models, operating system support. Distributed file systems – introduction- time and global states – synchronization of physical clocks – coordination and agreements: Mutual exclusion, election, consensus.

Text Books

1. George Coulouris , Jean Dollimore , Tim Kindberg , Gordon BlairDISTRIBUTED SYSTEMS Concepts and Design Fifth Edition , Addison Wiley, 2012.
2. Calvin Lin ,Larry Snyder, Principles of Parallel Programming, Pearson, 2009

References

1.Bertil Schmidt, Jorge Gonzalez-Dominguez, Christian Hundt , Moritz Schlarb, Parallel Programming: Concepts and Practice 1st Edition, Morgan Kaufmann, 2017.
2. Ajay D. Kshemkalyani, MukeshSinghal , Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, first edition, 2008.

24CSC546 HIGH PERFORMANCE COMPUTING 2 0 2 3

Parallel and Distributed Programming Models: Introduction to high performance computing, basic definitions: cluster, grid, meta-computing, middleware etc., examples of representative applications. Programming models: shared memory, message passing, peer-to-peer. Development of parallel and distributed applications, Design phases, Common parallel patterns, Performance metrics and profiling.

Overview of Cluster Computing: The Role of Clusters, Definition and Taxonomy, Distributed Computing, Limitations, Architecture of cluster-based systems, Design Decisions, Network Hardware, Network Software, Protocols Distributed File Systems, Virtualization technologies, Issues in cluster design: performance, single-system-image, fault tolerance, manageability, programmability, load balancing, security, storage. Introduction of Grid Computing: Introduction, Evolution of the Grid, Definitions of Grid Computing, Infrastructure of hardware and software, Grid models, Applications, Examples of usage, Research possibilities / scope in Grid Computing, HPC and Grids, Scheduling HPC applications in Grids, Grid Monitoring Architecture (GMA) – An Overview of Grid Monitoring Systems.

Integrating task parallelism with data parallelism: Introduction and motivation, A model for integrating task parallelism into data parallel programming platforms, Integration of the model into ARC, Design and implementation applications, performance analysis, guidelines for composing user programs, related work. Anonymous remote computing and communication model: Introduction, Location in dependent inter task communication with DP, DP model of iterative grid computations, Design and implementationofdistributedpipes.

TextBooks/References:
1."Grid Computing a Research Monograph" by D. Janakiram, Tata McGraw hill publications
2.Joshy Joseph & Craig Fellenstein, "Grid Computing", Pearson Education
3."Grid Computing: A Practical Guide to technology and Applications" by Ahmar Abbas, Charles River media.

24CSC547   Advance Deep Learning   2 0 2 3

Transfer learning in CNN and RNN such as using image classifiers, text classification, sentimental analysis.

Attention models and Deep reinforcement learning. Generative models (Generative Adversarial Network).tf.keras, TensorFlow Hub, and TensorFlow Lite tools.

Graph Convolution Networks.

Text / Reference Books:

1.Francios Chollet, Deep Learning with Python by.
2.Paolo Galeone, Hands-On Neural Networks with TensorFlow 2.0, by.
3.Michael Nielsen, Neural Networks and Deep Learning, by. Available for free online.
4.Goodfellow, Bengio, and Courville, Deep Learning Book, MIT Press.
5.R. Sutton and A. Barto, Reinforcement Learning: An Introduction, MIT Press.

24CSC548   ADVANCED BIG DATA ANALYTICS   2-0-2-3

How MapReduce Works - Anatomy of a MapReduce Job Run, Failures, Shuffle and Sort, Task Execution MapReduce Types and Formats - MapReduce Types, Input Formats, output formats, MapReduce Features- Counters, Sorting, Joins, Side Data Distribution

Simple analytics using MapReduce, Calculating frequency distributions and sorting using MapReduce, Calculating histograms using MapReduce, Calculating scatter plots using MapReduce. Hierarchical clustering, Clustering algorithm to large dataset, classification using Navie bayes classifier, other applications.

TEXT BOOKS /References:
1. Tom White , Hadoop: The Definitive Guide, Fourth Edition , O'Reilly Media ,2009

2. Srinath Perera and Thilina Gunarathne , Hadoop MapReduce Cookbook : Recipes for analyzing

large and complex datasets with Hadoop MapReduce, Packt PublishingLtd,2013

24CSC549   **Computer Aided Drug Designing**   **2 0 2 3**

Introduction to Molecular Modeling: Molecular Modeling and Pharmacoinformatics in Drug Design, Phases of Drug Discovery, Target identification and validation Protein Structure Prediction and Analysis: Protein Structure prediction methods: Secondary Structure

Prediction, Tools for Structure prediction; Protein structural visualization; Structure validation tools; Ramachandran Plot. QSAR : Quantitative Structure and Activity Relationship - Historical Development of QSAR, Tools and Techniques of QSAR, Molecular Structure Descriptors.

Multivariate Statistical methods in QSAR -Principal Component Analysis (PCA) and Hierarchical

Cluster Analysis(HCR). Regression analysis tools - Pincipal Component Regression (PCR), Partial Least Squares (PLS) - Case studies.

High Throughput / Virtual screening- Introduction, Basic Steps, Important Drug Databases, Designing Lipinski's Rule of Five, ADMET screening.

Docking Studies- Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking. Molecular visualization tools: RasMol and Swiss-Pdb Viewer Molecular docking tools: AutoDock and ArgusLab.

References/ TEXT BOOKS

Leach Andrew R., Valerie J. Gillet, An introduction to Chemoinformatics. Publisher: Kluwer academic ,2003. ISBN: 1402013477.

1.Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes), 2003.

2.Publisher: Wiley-VCH. ISBN:3527306803.

3.Opera Tudor I,Ed. , Chemoinformatics in drug discovery, Wiley-VCH Verlag,2005.

4.Bunin Barry A. Siesel Brian,Morales Guillermo,Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006. ISBN: 1402050003.

5.Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: WileyVCH; 1st edition. 2003. ISBN: 3527306811.

6.Kenneth M Merz, Jr, Dagmar Ringe, Charles H. Reynolds , Drug design: Structure and ligand based approaches (2010) publisher : Cmabridge University press.

24CSC550   Randomized Algorithm   2 0 2 3

Basic probability theory; randomized complexity classes; game-theoretic techniques; Markov, Chebyshev, and moment inequalities; limited independence; coupon collection and occupancy problems; tail inequalities and the Chernoff bound; conditional expectation; the probabilistic method; Markov chains and random walks; algebraic techniques; probability amplification and derandomization.

Lovasz Local Lemma and applications, the method of conditional probabilities. Randomized Data Structures: Hashing. Fingerprinting, Schwarzt-Zippel, Pattern Matching.Applications: Sorting and searching; data structures; combinatorial optimization and graph algorithms; geometric algorithms and linear programming; approximation and counting problems; parallel and distributed algorithms; online algorithms.

Text Books:

1. Motwani, and Raghavan. Randomized Algorithms. Cambridge, UK: Cambridge University Press, 1995.
2. Feller, William. An Introduction to Probability Theory and Its Applications.Vol. 1. New York, NY: John Wiley.
3 .Michael Mitzenmacher and Eli Upfal. Probability and Computing: Randomized Algorithms and Probabilistic Analysis., Cambridge University Press, 2nd edition.

24CSC551   Data Analytics in Computational Biology   2 0 2 3

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 (Genbank, EMBL, DDBJ, Swiss Prot , PDB, NDB, BLOCKS, Pfam, ProSITE, etc.).

Sequence alignment methods: Sequence analysis of biological data-Significance of sequence alignment- 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. Sequence alignment tools (BLAST, FASTA, CLUSTAL-W/X, MUSCLE, TCOFFEE), Variants of BLAST (BLASTn, BLASTp, PSIBLAST, PHI-BLA Phylogenetic analysis algorithms: Maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor-Joining, jackknife, Probabilistic models and associated algorithms

such as Probabilistic models of evolution and maximum likelihood algorithm, Bootstrapping methods, use of tools such as PHYLIP, MEGA, PAUP.

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 To Bioinformatics ,Pearson Education Singapore Pte Ltd, 2007
4. Mount, DW, Bioinformatics: Sequence and Genome analysis", Second edition, Cold Spring Harbor
5. Laboratory Press. Baxevanis 5. A.D., Davison D.B., Page R. D. M. & Petsko G.A. Current Protocols in Bioinformatics. New York, John Wiley & Sons Inc., 2004. ISBN: 0555015254
6 S.C. Rastogi et al, Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) Kindle Edition.

24CSC552   Image Processing and Computer Vision   2 0 2 3

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.

24CSC553   Multimedia Systems   2 0 2 3

Digital Signal Processing: Waveforms, Amplitude, Frequency and Phase Signal to Noise ratio and Decibel Scales, Signal Flow Graphs, Digital Signal Filtering, Finite Impulse Response.

Fourier Transform: Frequency components of Audio and Video Data, Frequency Domain, Fourier's theorem: 1D and 2D transforms, Magnitude and Phase Spectra, Time-Frequency Representation.

Digital Filters: Low Pass Filters: Ideal, Butterworth, Filtering Noisy Images, High Pass and Band-Pass Filters, Fourier Transform and Convolution.

Multimedia Data: Discrete and Continuous Media, Analog and Digital Signals: Analog/Digital Converter, Text and Static Data, Audio: digitising Sound, Graphics, Images and Video.

Digital Audio: MIDI and MPEG-4, Nyquist Sample Rate and Bit Size, MIDI: definition, components, hardware aspects, Messages, Channels, Structured Audio, MIDI Semantics and Control, Common Digital Audio Formats.

Graphics, Images and Videos: Graphic/Image File Formats: 24-bit and 8-bit colors, BitMaps, Gray Scale and Dithering, Graphic Formats: GIF, JPEG, TIFF, PNG, EPS. RGB and CMY Color

Models, Chrominance, Luma, Luminance and Gamma Correction, Color Vision: Photoreceptors, Cone Sensitivity and Color Propert.

Compression Algorithms: Coding and Decoding Algorithms.

Text Books:

1. Fundamentals of Multimedia: Ze-Nian Li & Mark S. Drew, Pearson Prentice Hall, 2004
2. Digital Signal Processing: Steven W. Smith, California Technical Publishing, 1999
3. Digital Signal Processing System-Level Design Using LabVIEW: Nasser Kehtarnavaz & Namjin Kim, Elsevier, 2005
4. Digital Signal Processing: a Filtering Approach: Steve White, Delmar Cengage Learning, 2000