School of Computing

(AMARAVATI, AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)

Curriculum and Syllabi

B.Tech - Computer Science and Engineering

CURRICULUM & SYLLABUS 2023 onwards

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat - Category
L - Lecture
T - Tutorial
P - Practical
Cr - Credits
ENGG - Engineering Sciences (including General, Core and Electives)
HUM - Humanities (including Languages and others)
SCI - Basic Sciences (including Mathematics)
PRJ - Project Work (including Seminars)
AES - Aerospace Engineering
AIE - Computer Science and Engineering - Artificial Intelligence
BIO - Biology
CCE - Computer and Communication Engineering
CHE - Chemical Engineering
CHY - Chemistry
CSE - Computer Science and Engineering
CVL - Civil Engineering
CUL - Cultural Education
EAC - Electronics and Computer Engineering
ECE - Electronics and Communication Engineering
EEE - Electrical and Electronics Engineering
ELC - Electrical and Computer Engineering
HUM - Humanities
MAT - Mathematics
MEE - Mechanical Engineering
PHY – Physics
CGPA - Cumulative Grade Point Average

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEO):

• Graduate will strive on a global platform to pursue their professional career in Computer Science and Engineering.
• Graduate will contribute to product development as entrepreneurs in inter-disciplinary fields of engineering and technology.
• Graduate will demonstrate high regard for professionalism, integrity and respect values in diverse culture, and have a concern for society and environment.

PROGRAM SPECIFIC OUTCOMES (PSO):

• Ability to design and implement innovative, optimal and elegant computing solutions to interdisciplinary problems using standard practices, tools and technologies.
• Ability to learn emerging computing paradigms for research and innovation

Department of Computer Science and Engineering
2023 Onwards

General Framework

CATEGORY	DESCRIPTION	No. of COURSES	CREDITS	AICTE Reco
HUMANITIES	Languages and Humanities	10	19	16
SCIENCES	Science Courses	6	23	23
ENGINEERING	Engineering Sciences	11	27	29
CSE	Computer Science – Core	13	52	59
CSE	Electives	6	18	12
ENGINEERING	Open Subjects - Electives from other technical and /or emerging subjects	3	8	9
PROJECT	Project	3	15	15
	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	2	(Non-Credit)	(Non-Credit)
	TOTAL		162	163

CURRICULUM 2023 onwards

Semester I					
Cat	**Code**	**Title**	**L T P**	**Credit**	**Evaluation Pattern**
HUM	23ENG101	Technical Communication	2-0-3	3	70:30
SCI	23MAT107	Calculus	3-0-2	4	70:30
CSE	23CSE101	Computational Problem Solving	3-0-2	4	70:30
ENGG	23EEE104	Introduction to Electrical and Electronics Engineering	3-0-0	3	50:50
ENGG	23EEE184	Basic Electrical and Electronics Engineering Practice	0-0-2	1	80:20
ENGG	23CSE102	Computer Hardware Essentials	1-0-2	2	70:30
HUM	22ADM101	Foundations of Indian Heritage	2-0-1	2	50:50
HUM	22AVP103	Mastery Over Mind	1-0-2	2	80:20
		Total (14 L + 1 T + 13 P = 28 hrs)		21	

Semester II					
Cat	**Code**	**Title**	**L T P**	**Credit**	**Evaluation Pattern**
SCI	23MAT116	Discrete Mathematics	3-0-2	4	70:30
SCI	23MAT117	Linear Algebra	3-0-2	4	70:30
CSE	23CSE111	Object Oriented Programming	3-0-2	4	70:30
SCI	23PHY115	Modern Physics	2-1-0	3	50:50
CSE	23CSE113	User Interface Design	2-0-2	3	70:30
ENGG	23MEE115	Manufacturing Practice	0-0-3	1	80:20
HUM	22ADM111	Glimpses of Glorious India	2-0-1	2	50:50
		Total (15L + 1T + 11P = 27hrs)		21	

Semester III					
Cat	**Code**	**Title**	**L T P**	**Credit**	**Evaluation Pattern**
SCI	23MAT206	Optimization Techniques	3-0-2	4	70:30
ENGG	23CSE205	Digital Electronics	3-0-0	3	60:40
CSE	23CSE201	Procedural Programming using C	3-0-2	4	70:30
CSE	23CSE202	Database Management Systems	3-0-2	4	70:30
CSE	23CSE203	Data Structures and Algorithms	3-1-2	5	70:30
ENGG	23CSE285	Digital Electronics Laboratory	0-0-3	1	80:20
HUM	23LSE201	Life Skills for Engineers I	1 0 2	P/F	50:50
HUM		Amrita Value Programme I	1-0-0	1	
		Total (19L + 1T + 11P = 31 hrs)		22	

Semester IV					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
SCI	23MAT216	Probability and Random Processes	3-0-2	4	70:30
CSE	23CSE211	Design and Analysis of Algorithms	3-0-2	4	70:30
CSE	23CSE212	Principles of Functional Languages	2-0-2	3	70:30
ENGG	23CSE213	Computer Organization and Architecture	3-1-0	4	50:50
CSE	23CSE214	Operating Systems	3-0-2	4	70:30
HUM		Amrita Value Programme II	1-0-0	1	
HUM		Free Elective I**	2-0-0	2	
HUM	23LSE211	Life Skills for Engineers II	1 0 2	2	50:50
		Total (20L + 1T + 8P = 29 hrs)		24	

Semester V					
Cat	**Code**	**Subject**	**L - T - P**	**Credits**	**Evaluation Pattern**
CSE	23CSE301	Machine Learning	3-0-2	4	70:30
CSE/ ENGG		Professional Elective I	3-0-0	3	70:30
CSE	23CSE302	Computer Networks	3-1-2	5	70:30
CSE	23CSE303	Theory of Computation	3-1-0	4	50:50
ENGG	23CSE304	Embedded Systems	3-0-2	4	70:30
CSE/ ENGG		Professional Elective II	3-0-0	3	70:30
HUM	23LSE301	Life Skills for Engineers III	1 0 2	2	50:50
ENGG	23LIV390	Live-in –Labs I***	[3]-0-0	[3]	
HUM	23ENV300	Environmental Science		P/F	
		Total (21L + 2T + 6P = 29hrs)		25+[3]	

Semester VI					
Cat	**Code**	**Subject**	**L - T - P**	**Credits**	**Evaluation Pattern**
ENGG	23CSE311	Software Engineering	3-0-2	4	70:30
ENGG	23CSE312	Distributed Systems	3-0-2	4	70:30
CSE	23CSE313	Foundations of Cyber Security	3-0-0	3	70:30
CSE/ ENGG		Professional Elective III	3-0-0	3	70:30
CSE	23CSE314	Compiler Design	3-0-2	4	70:30
PRJ	23CSE399	Project Phase-I	0-0-6	3	70:30
HUM	23LSE311	Life Skills for Engineers IV	1 0 2	2	50:50
ENGG	23LIV490*	Live-in –Labs II***	[3]-0-0	[3]	
		Total (18L + 0T +12P = 30 hrs)		23+[3]	

Semester VII					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
CSE/ENGG		Professional Elective IV	3-0-0	3	70:30
CSE/ENGG		Professional Elective V	3-0-0	3	70:30
CSE/ENGG		Professional Elective VI	3-0-0	3	70:30
ENGG		Free Elective II**	2-0-0	2	
CSE	23CSE401	Fundamentals of Artificial Intelligence	2-0-2	3	70:30
PRJ	23CSE498	Project - Phase II	0-0-12	6	70:30
HUM	23LAW300	Indian Constitution		P/F	
		Total (13L+0T+14P=27hrs)		20	

Semester VIII					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
PRJ	23CSE499	Project - Phase III	0-0-12	6	70:30
		Total (12 hrs)		6	
		Total Credits		162	

***** Free Electives will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam - (International Centre for Spiritual Studies).
******Professional Electives categorised under Engineering, Science, Mathematics, Live-in- Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8. If one student would like to opt for specialisation, the student must take the professional electives from the respective specialisation baskets.
*******Live-in-Labs - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester

Professional Electives

Electives in Cyber Security					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
CSE	23CSE331	Cryptography	3 0 0	3	70:30
CSE	23CSE332	Information Security	3 0 0	3	70:30
CSE	23CSE333	Secure Coding	3 0 0	3	70:30
CSE	23CSE334	Cyber Forensics and Malware	3 0 0	3	70:30
CSE	23CSE335	Block Chain and its Applications	3 0 0	3	70:30
ENGG	23CSE336	Secure Networks	3 0 0	3	70:30

Electives in Computer Networks					
Cat	**Code**	**Subject**	**L - T - P**	**Credits**	**Evaluation Pattern**
ENGG	23CSE341	Wireless Sensor Networks	3 0 0	3	70:30
ENGG	23CSE342	Advanced Computer Networks	3 0 0	3	70:30
ENGG	23CSE343	Wireless and Mobile Networks	3 0 0	3	70:30
ENGG	23CSE344	Modern Cellular Wireless Networks	3 0 0	3	70:30
CSE	23CSE345	Software Defined Networks	3 0 0	3	70:30

Electives in Data Science					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
CSE	23CSE351	Foundations of Data Science	3 0 0	3	70:30
CSE	23CSE352	Big Data Analytics	3 0 0	3	70:30
CSE	23CSE353	Data Visualization	3 0 0	3	70:30
CSE	23CSE354	Database Management Systems for Data Science	3 0 0	3	70:30
CSE	23CSE355	Mining of Massive Datasets	3 0 0	3	70:30
CSE	23CSE356	Social Network Analytics	3 0 0	3	70:30
CSE	23CSE357	Time Series Analysis and Forecasting	3 0 0	3	70:30

Electives in Cyber Physical Systems					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
ENGG	23CSE361	Real Time Operating Systems for Cyber- Physical Systems	3 0 0	3	70:30
ENGG	23CSE362	Edge Computing	3 0 0	3	70:30
ENGG	23CSE363	Cloud Computing	3 0 0	3	70:30
ENGG	23CSE364	Cyber Physical Systems	3 0 0	3	70:30
ENGG	23CSE365	Internet of Things	3 0 0	3	70:30

Electives in Computer Vision					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
CSE	23CSE371	Digital Image Processing	3 0 0	3	70:30
CSE	23CSE372	Computer Graphics and Animation	3 0 0	3	70:30
CSE	23CSE373	Computer Vision	3 0 0	3	70:30
CSE	23CSE374	Video Analysis	3 0 0	3	70:30
CSE	23CSE375	Augmented and Virtual Reality	3 0 0	3	70:30

Electives in Artificial Intelligence					
Cat	**Code**	**Subject**	**L - T – P**	**Credits**	**Evaluation Pattern**
CSE	23CSE470	Semantic Web	3 0 0	3	70:30
CSE	23CSE471	Natural Language Processing	3 0 0	3	70:30
CSE	23CSE472	Artificial Intelligence and Robotics	3 0 0	3	70:30
CSE	23CSE473	Neural Networks and Deep Learning	3 0 0	3	70:30
CSE	23CSE474	Computational Intelligence	3 0 0	3	70:30
CSE	23CSE475	Generative AI	3 0 0	3	70:30
CSE	23CSE476	Conversational AI	3 0 0	3	70:30
CSE	23CSE477	Reinforcement Learning	3 0 0	3	70:30
CSE	23CSE478	Drones and Robotics	3 0 0	3	70:30
CSE	23CSE479	Machine Learning with Graphs	3 0 0	3	70:30
CSE	23CSE480	AI for Industrial Decision Making	3 0 0	3	70:30

General Electives

Cat	Code	Subject	L - T - P	Credits	Evaluation Pattern
CSE	23CSE451	Graph Mining	3-0-0	3	70:30
CSE	23CSE452	Business Analytics	3-0-0	3	70:30
CSE	23CSE453	Competitive Programming	3-0-0	3	70:30

CSE	23CSE454	Concurrent Programming	3-0-0	3	70:30
CSE	23CSE455	Design Patterns	3-0-0	3	70:30
CSE	23CSE456	Domain Specific Languages	3-0-0	3	70:30
CSE	23CSE457	Elements of Computing	3-0-0	3	70:30
CSE	23CSE458	Embedded Programming	3-0-0	3	70:30
ENGG	23CSE459	Fault tolerant Computing Systems	3-0-0	3	70:30
CSE	23CSE460	Features in Modern Programming Languages	3-0-0	3	70:30
CSE	23CSE461	Full Stack Frameworks	3-0-0	3	70:30
CSE	23CSE462	Multimedia Communication Systems	3-0-0	3	70:30
CSE	23CSE463	Quantum Computing	3-0-0	3	70:30
CSE	23CSE464	Formal Verification	3-0-0	3	70:30
CSE	23CSE465	Mobile Application Development	3-0-0	3	70:30
CSE	23CSE466	Parallel Programming	3-0-0	3	70:30

Professional Electives for Other Branches

Cat	Code	Subject	L - T - P	Credits	Evaluation Pattern
CSE	23CSE431	Principles of Artificial Intelligence	3 0 0	3	70:30
CSE	23CSE432	Principles of Operating Systems	3 0 0	3	70:30
CSE	23CSE433	Fundamentals of Software Engineering	3 0 0	3	70:30
CSE	23CSE434	Introduction to Big Data Analytics	3 0 0	3	70:30
CSE	23CSE435	Foundation of Information Technology	3 0 0	3	70:30
CSE	23CSE436	Principles of Database Management Systems	3 0 0	3	70:30
CSE	23CSE437	Principles of Computer Networks	3 0 0	3	70:30
CSE	23CSE438	Object Oriented Programming	3 0 0	3	70:30

CSE	23CSE439	Introduction to Data Structures and Algorithms	3 0 0	3	70:30
CSE	23CSE440	Advanced Algorithms and Analysis	3 0 0	3	70:30
CSE	23CSE441	Introduction to Machine Learning	3 0 0	3	70:30
ENGG	23CSE442	Distributed Systems	3 0 0	3	70:30
ENGG	23CSE443	Cloud and IOT	3 0 0	3	70:30

List of courses in Amrita Value Programme I & II			
Course Code	Title	L-T-P	Credits
22ADM201	Strategic Lessons from Mahabharatha	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 Defense	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Course Code**	**Title**	**L T P**	**Credit**
SCI	23CHY240	Computational Chemistry and Molecular Modelling	3 0 0	3
SCI	23CHY241	Electrochemical Energy Systems and Processes	3 0 0	3
SCI	23CHY242	Fuels and Combustion	3 0 0	3
SCI	23CHY243	Green Chemistry and Technology	3 0 0	3
SCI	23CHY244	Instrumental Methods of Analysis	3 0 0	3
SCI	23CHY245	Batteries and Fuel Cells	3 0 0	3
SCI	23CHY246	Corrosion Science	3 0 0	3
PHYSICS				
SCI	23PHY240	Advanced Classical Dynamics	3 0 0	3
SCI	23PHY241	Electrical Engineering Materials	3 0 0	3
SCI	23PHY242	Physics of Lasers and Applications	3 0 0	3
SCI	23PHY243	Concepts of Nanophysics and Nanotechnology	3 0 0	3
SCI	23PHY244	Physics of Semiconductor Devices	3 0 0	3
SCI	23PHY245	Astrophysics	3 0 0	3
Mathematics				
SCI	23MAT240	Statistical Inference	3 0 0	3
SCI	23MAT241	Introduction to Game Theory	3 0 0	3
SCI	23MAT242	Numerical Methods and Optimization	3 0 0	3

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	**Course Code**	**Title**	**L T P**	**Credit**
HUM	23MNG331	Financial Management	3 0 0	3
HUM	23MNG332	Supply Chain Management	3 0 0	3
HUM	23MNG333	Marketing Management	3 0 0	3
HUM	23MNG334	Project Management	3 0 0	3
HUM	23MNG335	Enterprise Management	3 0 0	3
HUM	23MNG336	Operations Research	3 0 0	3
HUM	23MEE321	Industrial Engineering	3 0 0	3
HUM	23MEE322	Managerial Statistics	3 0 0	3
HUM	23MEE323	Total Quality Management	3 0 0	3
HUM	23MEE324	Lean Manufacturing	3 0 0	3
HUM	23CSE321	Software Project Management	3 0 0	3
HUM	23CSE322	Financial Engineering	3 0 0	3
HUM	23CSE323	Engineering Economic Analysis	3 0 0	3
HUM	23CSE324	Information Systems	3 0 0	3

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS				
Cat.	Course Code	Title	L T P	Credit
HUM	23CUL230	Achieving Excellence in Life - An Indian Perspective	2 0 0	2
HUM	23CUL231	Excellence in Daily Life	2 0 0	2
HUM	23CUL232	Exploring Science and Technology in Ancient India	2 0 0	2
HUM	23CUL233	Yoga Psychology	2 0 0	2
HUM	23ENG230	Business Communication	1 0 3	2
HUM	23ENG231	Indian Thought through English	2 0 0	2
HUM	23ENG232	Insights into Life through English Literature	2 0 0	2
HUM	23ENG233	Technical Communication	2 0 0	2
HUM	23ENG234	Indian Short Stories in English	2 0 0	2
HUM	23FRE230	Proficiency in French Language (Lower)	2 0 0	2
HUM	23FRE231	Proficiency in French Language (Higher)	2 0 0	2
HUM	23GER230	German for Beginners I	2 0 0	2
HUM	23GER231	German for Beginners II	2 0 0	2
HUM	23GER232	Proficiency in German Language (Lower)	2 0 0	2
HUM	23GER233	Proficiency in German Language (Higher)	2 0 0	2
HUM	23HIN230	Hindi I	2 0 0	2
HUM	23HIN231	Hindi II	2 0 0	2
HUM	23HUM230	Emotional Intelligence	2 0 0	2
HUM	23HUM231	Glimpses into the Indian Mind - the Growth of Modern India	2 0 0	2
HUM	23HUM232	Glimpses of Eternal India	2 0 0	2
HUM	23HUM233	Glimpses of Indian Economy and Polity	2 0 0	2
HUM	23HUM234	Health and Lifestyle	2 0 0	2
HUM	23HUM235	Indian Classics for the Twenty-first Century	2 0 0	2
HUM	23HUM236	Introduction to India Studies	2 0 0	2
HUM	23HUM237	Introduction to Sanskrit Language and Literature	2 0 0	2
HUM	23HUM238	National Service Scheme	2 0 0	2
HUM	23HUM239	Psychology for Effective Living	2 0 0	2
HUM	23HUM240	Psychology for Engineers	2 0 0	2
HUM	23HUM241	Science and Society - An Indian Perspective	2 0 0	2
HUM	23HUM242	The Message of Bhagwat Gita	2 0 0	2
HUM	23HUM243	The Message of the Upanishads	2 0 0	2
HUM	23HUM244	Understanding Science of Food and Nutrition	2 0 0	2
HUM	23HUM245	Service Learning	2 0 0	2
HUM	23JAP230	Proficiency in Japanese Language (Lower)	2 0 0	2
HUM	23JAP231	Proficiency in Japanese Language (Higher)	2 0 0	2
HUM	23KAN230	Kannada I	2 0 0	2
HUM	23KAN231	Kannada II	2 0 0	2
HUM	23MAL230	Malayalam I	2 0 0	2
HUM	23MAL231	Malayalam II	2 0 0	2
HUM	23SAN230	Sanskrit I	2 0 0	2
HUM	23SAN231	Sanskrit II	2 0 0	2
HUM	23SWK230	Corporate Social Responsibility	2 0 0	2
HUM	23SWK231	Workplace Mental Health	2 0 0	2
HUM	23TAM230	Tamil I	2 0 0	2
HUM	23TAM231	TAMIL II	2 0 0	2

B.Tech - Computer Science and Engineering

SYLLABUS 2023 onwards

SEMESTER I

23ENG101	TECHNICAL COMMUNICATION	L-T-P-C:2-0-3-3

Course Objectives

- Learn the fundamentals of mechanics of writing.
- Acquire the ability to draft formal correspondence and various technical documents.
- Develop abilities in critical thinking and analysis.
- Acquire skills of scanning for specific information, comprehension, and organization of ideas.
- Enhance competency in technical presentation skills.

Course Outcomes

CO1: Apply the mechanics of writing in formal correspondence
CO2: Write technical documents with appropriate form and content
CO3: Organize technical information or ideas in a logical and coherent manner
CO4: Compose grammatically and stylistically accurate project reports/ term papers
CO5: Make effective technical presentations

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2				1						2				
CO3										3				
CO4				1						2				
CO5									2	1				

Syllabus

Unit 1
Error Analysis
Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers, impersonal passive, modifiers, phrasal verbs
General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2
Different kinds of written documents: Definitions- Descriptions- Instructions-Recommendations- User manuals - Reports – Proposals
Formal Correspondence: Writing Formal Letters/Emails
Punctuation
Scientific Reading & Listening Comprehension

Unit 3
Technical paper writing: Documentation style - Document editing – Proof reading - Organizing and Formatting
Tone and style
Graphical representation
Reading and listening comprehension of technical documents
Mini Technical project / Term paper (10 -12 pages)
Technical presentations

References(s)

Hirsh, Herbert. L, "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002.
Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003.
Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan & Bacon, 1999.
Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today", VIII Edition (Indian Adaptation).New Delhi: Biztantra, 2004.
Michael Swan. "Practical English Usage", Oxford University Press, 2000.

Evaluation Pattern: 70:30

Assessment	Internal (Weightage)	End Semester (Weightage)
CA	30	
Mid-term	30	
End Semester		40

23MAT107	CALCULUS	L-T-P-C: 3-0-2-4

Course Objectives

Understand the various functions and their graphs. The basic concept of continuous function and find the extreme values of the continuous functions. Also, to understand parameterisation of curves and to find arc length and familiarise with calculus of multiple variables.

Course Outcomes

CO1: To understand the concepts of shifting, scaling of functions, limits, continuity, and differentiability.
CO2: To understand the definite integral and compute the definite integral for standard functions.
CO3: To understand the limits, continuity and partial derivatives of multivariable functions and its computations.
CO4: To understand the scalar and vector fields, gradient, divergence and curl of vector fields and their physical interpretations.
CO5: To understand the computing techniques of line integral, surface integral and volume integrals.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-			
CO2	2	2	-	-	2	-	-	-	-	-	-			
CO3	2	2	-	-	1	-	-	-	-	-	-			
CO4	2	2	-	-	1	-	-	-	-	-	-			
CO5	1	2	-	-	-	-	-	-	-	-	-			

Syllabus

Unit 1
Graphs: Functions and their Graphs. Shifting and Scaling of Graphs. Limit and Continuity: Limit (One Sided and Two Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity. Graphing: Extreme Values of Functions, Concavity and Curve Sketching, Integration: Definite Integrals, The Mean Value Theorem for definite integrals, Fundamental Theorem of Calculus, Integration Techniques.

Unit 2
Functions of severable variables: Functions, limit and continuity. Partial differentiations, total derivatives, differentiation of implicit functions and transformation of coordinates by Jacobian. Taylor's series for two variables. Vector Differentiation: Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Unit 3
Vector Integration: Line Integral, Line Integrals Independent of Path. Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke's Theorem.

Textbook(s)
G.B. Thomas, "Calculus", Pearson Education, 2009, Eleventh Edition.

Reference(s)
Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, "Calculus", 3rd Edition, 2002.
E Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, Tenth Edition, 2018.
Dennis G. Zill and Michael R.Cullen, "Advanced Engineering Mathematics", second edition CBS Publishers, 2012.

Lab Experiments:
1. Basic commands in MATLAB (Vectors, matrices)
2. Plotting of single variable functions
3. Plotting of functions using concepts of shifting, scaling, reflection
4. Derivatives and Evaluation of derivatives numerically using excel
5. Solutions to differential equations numerically-RC, LC, RL circuits (using excel)
6. Velocity and acceleration
7. Definite Integrals – evaluation numerically
8. Taylor series expansion for single and multi variable functions
9. Plotting of two-variable functions-surface plots using parametric representation

10. Contour plots to identify the optimum
11. Gradient of scalar functions and plotting of gradient vectors
12. Hessian to identify the concavity of the surface
13. Divergence and Curl of a vector field

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Lab Practice, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23CSE101	COMPUTATIONAL PROBLEM SOLVING	L-T-P-C: 3-0-2-4

Course Objectives

The objective of this course is to introduce the computational aspects of problem solving to the students. The course exposes computational thinking to the students through systematic treatment on algorithms, logical reasoning and solutions. The course then introduces Python language which will be used as a computational tool for both designing algorithms and solving problems.

Course Outcomes

CO1: Apply algorithmic thinking to understand, define and solve problems.
CO2: Design and implement algorithm(s) for a given problem.
CO3: Apply the basic programming constructs for developing solutions and programs.
CO4: Analyze an algorithm by tracing its computational states, identifying bugs and correcting them.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2										2	2
CO2	3	2	3		3								2	2
CO3	2	2	2		2								2	2
CO4	2	1	1		2								2	2

Syllabus
Unit 1
Problem Solving and Algorithmic Thinking Overview – Algorithms - Properties, Constituents of Algorithms: Sequence, Selection and Repetition - Designing Algorithms, Expressing and Analyzing Algorithms - Algorithms vs Programs - Logical Reasoning - Logical Errors - Problem Definition - Problem Understanding and Analysis - Designing Solutions.

Unit 2
Overview of Programming Paradigms - Introduction to Python - Variables - Strings, IO - Control Flow - Data Abstraction: Working with Lists/Arrays, Dictionaries, Tuples and Sets - Functions - Recursion - Files - Debugging - Computational Tracing of Python Programs.

Unit 3
Problem Solving with Algorithms - Searching and Sorting - Applied Computational Thinking Problems: Python Libraries, Text Processing, Data Processing and Analysis, Chatbot etc.

Textbook(s)
Sofia De Jesus and Dayrene Martinez, "Applied Computational Thinking with Python: Design algorithmic solutions for complex and challenging real-world problems", Packt Publishing, November 2020.

Reference(s)
Thomas Mailund, "Introduction to Computational Thinking: Problem Solving, Algorithms, Data Structures, and More", Apress, 2021.
Karl Beecher, "Computational Thinking: A beginner's guide to problem-solving and programming", BCS, The Chartered Institute for IT, 2017.
Curzon P, McOwan PW, "The Power of Computational Thinking: Games, Magic and Puzzles to help you become a computational thinker", World Scientific Publishing Company; 2017.

Evaluation Pattern - 70:30

Assessment	Internal	External
Mid Term Examination	20	-
*Continuous Assessment - Theory	10	-
*Continuous Assessment - Lab	40	-
**End Semester	-	30 (50 Marks - 2 hours)

*Continuous Assessment – Can be Quizzes, Assignments, Case Studies, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23EEE104	INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
- Understand the characteristics and applications of diode and Transistors.
- To facilitate understanding of Thyristors and operational amplifier circuits.

Course Outcomes

CO1: Ability to understand the basic electric and magnetic circuits.
CO2: Ability to analyze DC and AC circuits.
CO3: Ability to understand the basic principles of pn junctions and transistors.
CO4: Ability to analyze basic transistor and op amp-based circuits.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1

Introduction to Electrical Engineering, current and voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Energy and Power – Series parallel combination of R, L, C components,Voltage Divider and Current Divider Rules – Super position Theorem, Network Analysis – Mesh and Node methods- Faraday's Laws of Electro-magnetic Induction, Magnetic Circuits, Self and Mutual Inductance, Generation of sinusoidal voltage, Instantaneous, Average and effective values of periodic functions, Phasor representation. Introduction to 3-phase systems, Introduction to electric grids.

Unit 2

PN Junction diodes, Diode Characteristics, Diode approximation- Clippers and Clampers, Rectifiers: Half wave, Full wave, Bridge- Zener Diode- Design of regulator and characteristics, Optoelectronic devices, Introduction to BJT, Characteristics and configurations, Transistor as a Switch.

Unit 3

Field Effect Transistors – Characteristics, Thyristors – operation and characteristics, Diac, Triac –Thyristor based power control, IC 555 based Timer-multi-vibrators, Operational Amplifiers – Inverting and Non-inverting amplifier, Oscillators, Instrumentation amplifiers.

Textbooks

Edward Hughes. "Electrical and Electronic Technology", 10th Edition, Pearson Education Asia, 2019.
A. P. Malvino, "Electronic Principles", 7th Edition, Tata McGraw Hill, 2007.
S. K. Bhattcharya, "Basic Electrical and Electronics Engineering", Pearson, 2012.
Vincent Del Toro, "Electrical Engineering Fundamentals", Prentice Hall of India Private Limited, 2nd Edition, 2003.
David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.
(Michael Tooley B. A., "Electronic circuits: Fundamentals and Applications", 3rd Edition, Elsevier Limited, 2006.

Evaluation Pattern: 50:50

Assessment	Internal	External
CA	30	
Mid-semester	30	
End Semester		40

23EEE184	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING PRACTICE	L-T-P-C: 0-0-2-1

Course Objectives

- To impart basic knowledge of electrical quantities and provide working knowledge for the analysis of DC and AC circuits.
- To facilitate understanding of basic electronics and operational amplifier circuits.

Course Outcomes

CO1: Create basic electrical connections for domestic applications.
CO2: Measure the various electrical parameters in the circuit.
CO3: Construct and analyze basic electronic circuits.
CO4: Develop amplifier circuits using Op-Amp.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	-	1	1	1	-	-	-	-	-
CO2	3	1	1	-	-	-	-	1	1	1	-	-	-	-	-
CO3	3	2	1	-	-	-	-	1	1	1	-	-	-	-	-
CO4	3	2	1	-	-	-	-	1	1	1	-	-	-	-	-

Syllabus

1. Electrical Wiring practices.
2. Study of Electrical protection systems.
3. Verification of circuit theorem.
4. VI characteristics of PN junction and Zener diode.
5. Implementation of Half wave and Full wave rectifier using PN junction diode.
6. Transistor as a switch.
7. Characteristics of BJT.
8. Experiment on Thyristor.
9. Implementation of inverting and non-inverting amplifier using Op-amp.
10. Experiments on Oscillators and Multivibrators.

Reference(s)
Lab Manual

Evaluation Pattern: 80:20

Assessment	Internal	External
*Continuous Assessment (CA)	60	
End Semester		40

23CSE102	COMPUTER HARDWARE ESSENTIALS	L-T-P-C: 1-0-2-2

Course Objectives

- This course is designed to introduce the students to the basics of computing devices, operating systems, installation, configuration, and troubleshooting.
- Elementary concepts of physical computing and Internet of Things are also covered.

Course Outcomes

CO1: Understand the working principles of different computing devices.
CO2: Understand hardware components used for building computing devices.
CO3: Understand the different types of sensors, actuators and methods of interfacing to computing devices.
CO4: Understand the fundamentals of physical computing and related use cases.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1			1							2	3	2
CO2	3	2			1							2	3	2
CO3	3	3	2		2			2	2	2		2	3	2
CO4	3	3	2		2			2	2	2		2	3	2

Syllabus

Unit 1
An overview of the hardware components used to build general purpose and single board computers, mobile phones and laptops, chipsets, interface standards, specifications, and configurations. Installation of operating systems and dual booting.

Unit 2
Introduction to physical computing, Sensors, actuators, digital and analog I/O ports, communicating over a wired/wireless network.

Unit 3
Introduction to Raspberry Pi, GPIO programming, interfacing sensors and actuators. Introduction to IoT, communicating sensor data to cloud platforms.

Textbook(s)
Banzi, Massimo, and Michael Shiloh. "Getting started with Arduino". Maker Media, Inc., 4th edition 2022.
Pan, T., Zhu, Y., "Getting Started with Arduino. In: Designing Embedded Systems with Arduino". Springer, Singapore, 2018
Molloy, Derek. "Exploring Raspberry Pi: interfacing to the real world with embedded Linux". John Wiley & Sons, 2016.

Reference(s)
Singh, Rajesh, et al. "Internet of things with Raspberry Pi and Arduino". CRC Press, 2019.

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30

*CA – Can be Quizzes/Assignment/Lab Practice
**End Semester - lab-based examination

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

Course Objectives

To introduce students to the depths and richness of the Indian culture and knowledge traditions, and to enable them to obtain a synoptic view of the grandiose achievements of India in diverse fields. To equip students with a knowledge of their country and its eternal values.

Course Outcomes

CO1: Increase student understanding of true essence of India's cultural and spiritual heritage. Emancipating Indian histories and practices from manipulation, misunderstandings, and other ideological baggage thus, shows its contemporary relevance.
CO2: Understand the ethical and political strategic concepts to induce critical approach to various theories about India.
CO3: Familiarize students with the multidimension of man's interaction with nature, fellow beings and society in general.
CO4: Appreciate the socio-political and strategic innovations based on Indian knowledge systems. Gives an understanding of bringing Indian teaching into practical life.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				2				2						
CO2		1				1	1	3						
CO3						1	2	3						
CO4	3					3	3	3						

Syllabus

Educational Heritage of Ancient India, Life and Happiness, Impact of Colonialism and Decolonization, A timeline of Early Indian Subcontinent, Pinnacle of Selflessness and ultimate freedom, Indian approach towards life, Circle of Life, Ocean of love; Indian Mahatmas, Man's association with Nature, Celebrating life 24/7, Metaphors and Tropes, Become A Strategic Thinker (Games / Indic activity), India: In the Views of Other Scholars and Travellers, Personality Development Through Yoga, Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness, Conversations on Compassion with Amma.

Textbook(s)

"Foundations of Indian Heritage", In house publication (In print).

Reference(s)

The beautiful tree by Dharampal.
Peasants and Monks in British India by William Pinch.
India, that is Bharat: Coloniality, Civilisation, Constitution by J Sai Deepak.
Awaken Children Dialogues with Mata Amritanandamayi.
Man and Nature by Mata Amritanandamayi Devi.
What Becomes of the Soul After Death, Divine Life Society.

Evaluation Pattern: 50:50

Assessment	Internal	End Semester
Term Project	30	
Mid-term	30	
End Semester		40

22AVP103	MASTERY OVER MIND	L-T-P-C:1-0-2-2

Course Objectives

- Mastery Over Mind (MaOM) is an Amrita initiative to implement schemes and organize university-wide programs to enhance health and wellbeing of all faculty, staff, and students (UN SDG -3).
- It gives an introduction to immediate and long-term benefits of MA OM meditation and equips every attendee to manage stressful emotions and anxiety, in turn facilitating inner peace and harmony.
- This course will enhance the understanding of experiential learning based on the 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.

Course Outcomes

CO1: To be able to describe what meditation is and to understand its health benefits.
CO2: To understand the causes of stress and how meditation improves well-being.
CO3: To understand the science of meditation.
CO4: To learn and practice MA OM meditation in daily life.
CO5: To understand the application of meditation to improve communication and relationships.
CO6: To be able to understand the power of meditation in compassion-driven action.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								1	2	2		2		
CO2			2		2				2	2		2		
CO3					2			2	2	2		2		
CO4			3		3		2	3	3	3		3		
CO5			2		2			2	2	3		3		
CO6			2					2	2	2		2		

Syllabus

The course syllabus will be covered in six units as described below

Unit 1: Describe Meditation and Understand its Benefits (CO1)
A: Importance of meditation. How does meditation help to overcome obstacles in life *(Pre- recorded video with Swami Shubhamritananda Puri)*
Reading 1: Why Meditate? (Swami Shubamritananda ji)
Reading 2: 'Stillness of the Mind' Chapter 17 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.
Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya)
B: Understand how meditation works. Understand how meditation helps in improving physical and mental health. Understand how meditation helps in the development of personality *(Pre-recorded video with Dr. Ram Manohar)*
Reading 1: Allen, Cynthia (2020) The Potential Health Benefits of Meditation
Additional Reading: Sharma, Hari (2022) Meditation: Process and Effects

Unit 2: Causes of Stress and How Meditation Improves Well-being (CO2)
A: Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (*Pre-recorded video with Dr. Ram Manohar)*
B: Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. *(Pre-recorded video with Prof Udhaykumar)*
Reading 1: Mayo Clinic Staff (2022, April 29). *Meditation: A Simple, Fast Way to Reduce Stress*. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in- depth/meditation/art-20045858 (PDF provided)
Reading 2: 'Efficient Action.' Chapter 28 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.

Unit 3: The Science of Meditation (CO3)
A: A preliminary understanding of the Science of meditation. What can modern science tell us about this tradition-based method? *(Pre-recorded video with Dr. Shyam Diwakar)*
B: How meditation helps humanity according to what we know from scientific research
(Pre-recorded video with Dr. Shyam Diwakar)
Reading 1: Does Meditation Aid Brain and Mental Health (Dr Shyam Diwakar)
Reading 2: 'Science and Spirituality.' Chapter 85 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.

Unit 4: Practicing MA OM Meditation in Daily Life (CO4)
Guided Meditation Sessions following scripts provided (Level One to Level Five)
Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)
Reading 2: 'Live in the Present Moment.' Chapter 71 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.

Unit 5: Improving Communication and Relationships (CO5)
How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace. *(Pre-recorded video with Dr Shobhana Madhavan)*
Reading 1: Seppala E (2022, June 30th) *5 Unexpected Ways Meditation Improves Relationships a Lot.* Psychology Today. https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways- meditation-improves-relationships-lot
Reading 2: 'Attitude.' Chapter 53 in *Amritam Gamaya* (2022). Mata Amritanandamayi Mission Trust.

Unit 6: Meditation and Compassion-driven Action (CO6)
Understand how meditation can help to motivate compassion-driven action. *(Pre- recorded video with Dr Shobhana Madhavan)*
Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know?. *Current Opinion in Psychology*, *44,* 151-156.
Reading 2: 'Sympathy and Compassion.' Chapter 100 in *Amritam Gamaya* (2022). Mata Amritanandamyi Mission Trust.

Textbook(s)/Reference(s):

1. Meditation and Spiritual Life-Swami Yatiswarananda, Ramakrishna Math
2. The Complete Works of Swami Vivekananda Vol Vii by Advaita Ashram Mayavati Almora Himalayas
3. Dhyana Yoga-Holy Gita Swami Chinmayanda
4. Voice of God, Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
5. Hindu Dharma-Chandrasekharendra Saraswati, 68th Acharya of Sri Kanchi Kamakoti Peetam,
6. Mind: It's Mysteries and control-Swami Sivananda Saraswati
7. Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.
8. Books on Amma's teachings like Awaken children, From Amma's Heart etc.
9. The Science of Meditation: How to Change Your Brain, Mind and Body by Daniel Goleman and Richard. J. Davidson.
10. Allen, Cynthia (2020) The Potential Health Benefits of Meditation
11. Seppala E (2022, June 30th Unexpected Ways Meditation Improves Relationships a Lot.Psychology Today
12. Sharma, Hari (2022) Meditation: Process and Effects
13. Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress.
14. Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial behavior: What do we (not) know? Current Opinion in Psychology, 44, 151-156

Course Outcomes and Bloom's Taxonomy:
Each of the course outcomes can be mapped to specific levels of Bloom's Taxonomy as described in Table 1 below

Table 1: Unit-wise Scope for Outcomes and Bloom's Taxonomy:

CO Bloom's Levels of Learning	CO1	CO2	CO3	CO4	CO5	CO6
Creating						
Evaluating					Yes	Yes
Analyzing					Yes	Yes
Applying			Yes	Yes	Yes	Yes
Understanding	Yes	Yes	Yes	Yes	Yes	Yes
Remembering	Yes	Yes	Yes	Yes	Yes	Yes

Evaluation Pattern: 80:20

Assessment	Internal	End semester
CA	80	
End Semester		20

SEMESTER II

23MAT116	DISCRETE MATHEMATICS	L-T-P-C: 3-0-2-4

Course Objectives

- Understand the logic and various functions.
- Understand the basic concept of combinatorics.
- Understand the concepts of recurrence relations and their applications.
- Understand the concepts of equivalence and partial order relations.
- Understand various definitions and theorems on graph theory.

Course Outcomes

CO1: To understand the basic concepts of Mathematical reasoning and basic counting techniques.
CO2: To understand the recursive functions and apply the concepts of generating functions to solve the recurrence relations.
CO3: Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.
CO4: To understand the concepts of various types of relations, partial ordering and equivalence relations.
CO5: To understand the basic concepts of graph theory and apply to shortest path problems.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO														
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	1	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	1	-	-	-	-	-	-	-	-	-
CO5	1	2	-	-	-	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving. Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations.

Unit 2
Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations and partitions.
Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion.

Unit 3
Graph Theory: 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. Hamilton cycles, Chinese-postman problem, approximate solutions of traveling salesman problem. Closest neighbour algorithm.

Lab Practice Problems: Verifications of logical statements, truth table, tautology. Recursive algorithms. Graph problems, degree, shortest path algorithm, Euler's algorithm and closest neighbour algorithm.

Textbook(s)
Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.
James Strayer, "Elementary Number Theory", Waveland Press, 2002.

Reference(s)

R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.
Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited , 2004.

Lab Experiments:

1. Program to construct truth tables for some compound propositions
2. Program to check the validity for all rules of inference using truth tables
3. Program to check whether a given function is one-one and / or onto
4. Programs on mathematical induction
5. Programs involving recursion-i : factorial, power, gcd, modular exponentiation
6. Programs involving recursion-ii : fibonnaci series, towers of hanoi
7. Program to check whether a given number is prime
8. Programs involving modelling of recurrence relations
9. Program to check different properties of relations- reflexivity, symmetry, antisymmetry, transitivity
10. Program to find transitive closure using warshalls algorithm
11. Programs on divisibility and factorization
12. Program on fundamental theorem of airthmetic
13. Program on chinese remainder theorem

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Lab Practice, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23MAT117	LINEAR ALGEBRA	L-T-P-C: 3-0-2-4

Course Objectives

Understand the basic concepts of vector space, subspace, basis and dimension. Also to understand the orthogonality concepts and apply to various problems computer science.

Course Outcomes

CO1: To understand the basic concepts of vector space, subspace, basis and dimension.
CO2: To understand the basic concepts of inner product space, norm, angle, Orthogonality and projection and implementing the Gram-Schmidt process, to compute least square solution.
CO3: To understand and compute the linear transformations.
CO4: To compute the eigen values and eigen vectors and apply to transformation problems.
CO5: To perform case studies on least square and image transformations.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	3	-	-	-	-	-	-	-		
CO2	2	2	-	-	2	-	-	-	-	-	-	-		
CO3	3	3	-	-	2	-	-	-	-	-	-	-		
CO4	2	2	-	-	1	-	-	-	-	-	-	-		
CO5	3	2	-	-	2	-	-	-	-	-	-	-		

Syllabus

Unit 1
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. QR- Decomposition.

Unit 2
Linear Transformations: Linear transformation - Relation between matrices and linear transformations - Kernel and range of a linear transformation - Change of basis - Nilpotent transformations. Symmetric and Skew Symmetric Matrices, Adjoint and Hermitian Adjoint of a Matrix, Hermitian, Unitary and Normal Transformations, Self-Adjoint and Normal Transformations.

Unit 3
Eigen values and Eigen vectors: Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms, Conic Sections. Similarity of linear transformations - Diagonalization and its applications - Jordan form and rational canonical form. Case Studies: Applications on least square and image transformations.

Textbook(s)

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

Reference(s)

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

Lab Experiments

1. Matrix operations, Generation of random matrices with given rank
2. Solution to linear system of equations, Left Inverse, Right Inverse, Pseudo Inverse
3. Revision of curve and surface plots using parametric representations

4. Span of a set (scatter plots for span of different sets)
5. Finding basis for row space, column space, null space and left null space
6. Finding orthogonal compliment of a given vector space
7. QR decomposition
8. Projections onto subspaces, Least Square Approximation, Linear Regression
9. Eigenvalues, Eigenvectors, characteristic polynomial.
10. Similar matrices, diagonalization, Cayley Hamilton Theorem.
11. Scaling, Shifting, Rotation of images using Linear Transformations

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Lab Practice, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23CSE111	OBJECT ORIENTED PROGRAMMING	L-T-P-C: 3-0-2-4

Course Objectives

- The course aims at teaching students to develop Object-Oriented software using the Unified Modelling Language and the Java Programming Language to first year students.
- This course motivates the students to think of problem solving in an Object-Oriented way using the methods and tools that support the paradigm.

Course Outcomes

CO1: Understand Object Oriented paradigm and represent the problem using objects and classes.
CO2: Apply the Object Oriented concepts to design and develop effective models using UML.
CO3: Develop program logic in Java from design models in UML.
CO4: Design applications with procedural and data abstraction using Java libraries.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1		2								3	2
CO2	3	3	2	1	2								3	2
CO3	1	2	3	2	3			2	2	2			3	2
CO4	2	2	3	3	2			2	2	3			3	2

Syllabus

Unit1

Structured to Object Oriented Approach by Examples - Object Oriented languages - Properties of Object Oriented system – UML and Object Oriented Software Development - Use case diagrams and documents as a functional model - Identifying Objects and classes - Representation of Objects and its state by Object Diagram - Simple Class using class diagram – Encapsulation - Data Hiding - Reading and Writing Objects - Class Level and Instance Level Attributes and Methods- JIVE environment for debugging.

Unit2

Aggregation and Composition using Class Diagram – Generalization using Class Diagram – Inheritance - `Constructor and Over Riding – Visibility – Attribute – Parameter – Package - Local and Global - Polymorphism – Overloading - Abstract Classes and Interfaces.

Unit3

Exception Handling - Inner Classes - Wrapper classes – String - and String Builder classes – Number – Math – Random - Array methods - File Streams - Serialization - Generics - Collection framework - Comparator and Comparable - Vector and Arraylist - Iterator and Iterable.

Textbook(s)

Y.Daniel Liang, "Introduction to Java Programming", Tenth Edition, PHI, 2013.
Grady Booch and Robert A. Maksimchuk, "Object-oriented Analysis and Design with Applications", Third Edition, Pearson Education, 2009.

Reference(s)

Naughton P. and Schildt H., "Java2 Complete Reference", Eighth Edition, Tata McGraw- Hill, 2011.
Ali Bahrami, "Object Oriented Systems Development", Second Edition, McGraw-Hill,2008.
Jaime Nino, Fredrick A Hosch, "An Introduction to Programming and Object Oriented Design using Java", Wiley India Private Limited, 2010.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Lab (CAL)	40	
*Continuous Assessment Theory (CAT)	10	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report, Case Study/project for 10 marks suggested.
**End Semester - lab-based examination

23PHY115	MODERN PHYSICS	L-T-P-C: 2-1-0-3

Course Objectives

The main objective of the course is to expose to the development of Physics with special emphasis onQuantum mechanics-which enable a computer science engineer to apply this in the field of emerging areas like quantum computing.

Course Outcomes

CO1: To be exposed to the fundamental concepts of Wave nature of Particles and Particle nature ofWaves.
CO2: To understand various atomic models and their application to phenomena like spectrumformation including LASERS.
CO3: To be introduced to the basics of Quantum mechanics like Wave function, Operators, States ofwave function etc.
CO4: To be able to apply quantum mechanics to simple applications like particle in a box, tunnellingof particle across a barrier etc. Equipment use in water treatment.
CO5: Apply Quantum mechanics in the emerging field of Quantum computing.

CO-PO Mapping

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

Syllabus

Unit 1
Origin of quantum theory of radiation: Black body radiation, photo-electric effect, Compton Effect – pair production and annihilation, De-Broglie hypothesis, description of waves and wave packets,group velocities. Evidence for wave nature of particles: Davisson-Germer experiment, Heisenberguncertainty principle.

Unit 2
Atomic structure: Historical Development of atomic structures: Thomson's Model, Rutherford's Model: Scattering formula and its predictions, Atomic spectra - Bohr's Model, Sommerfield's Model, The correspondence principle, nuclear motion, and atomic excitation, Application: Lasers.

Unit 3
Quantum mechanics: Wave function, Probability density, expectation values - Schrodinger equation – time dependent and independent, Linearity and superposition, expectation values, operators, Eigen functions and Eigen values

Unit 4
Application of 1D Schrodinger Wave equation: Free particle, Particle in a box, Finite potential well,Tunnel effect, Harmonic oscillator.

Unit 5
Intro to Quantum computing- Q bits- II Quantum correlations: Bell inequalities and entanglement,Schmidt decomposition, super dense coding, teleportation. Module

Textbook(s)

Arthur Beiser, Shobhit Mahajan, S Rai Choudhury, "Concepts of Modern Physics" - McGraw HillEducation (Ondia) Private Ltd, Sixth edition, 2009.

Eleanor G. Rieffel and Wolfgang H. Polak, "Quantum Computing, A Gentle Introduction", MIT press.

Reference(s)

R Shankar, "Principles of Quantum Mechanics", Pearson India (LPE), 2E, 2006.

L I Schiff, "Quantum Mechanics", TMH, 2E,2010.

Evaluation Pattern: 50:50

Assessment	Internal	End Semester
Mid-term	30	
Continuous Assessment (CA)	20	
End Semester		50

23CSE113	USER INTERFACE DESIGN	L-T-P-C:2-0-2-3

Course Objectives

The course focuses on the basic understanding of user interface design by applying HTML, CSS and Java Script. The course introduces the necessary skills to develop web applications with simple animation and transitions. An overview of UI Frameworks is given. Working of Internet is discussed. The protocols required are introduced.

Course Outcomes

CO1: To understand the basics and working of World Wide Web
CO2: To understand the fundamentals of HTML5
CO3: To understand the fundamentals of CSS and Java Script
CO4: To design and deploy a simple web application

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2			2	2						3	2
CO2	2	2	2							3			3	2
CO3	2	2	2					1		3			3	2
CO4	2	2	3	2	3			3	3				3	2

Syllabus

Unit 1
Introduction to Internet and Web design – Working of Web – Roles of Front-end, Back-end and Full stack development – Web Server – Internet protocols – Web Hosting – HTML – HTML Tags – Create a simple Web Page – Marking up Text – Adding Links – Adding Images – SVG – Table Markup – Embedded Media - Web Based Forms – HTML Forms - CSS for Presentation - Basic Style Sheet - A CSS Style Primer - Using Style Classes - Using Style IDs - Formatting Text - Advanced Typography with CSS3 - Working with Margins, Padding, Alignment, and Floating. Responsive web design, Introduction to version control systems.

Unit 2
CSS Box Model and Positioning - Creating Layouts Using Modern CSS - Backgrounds and Borders - CSS Transformations and Transitions - Animating with CSS and the Canvas - Dynamic Web Pages – Web Scripting - JavaScript programming for Web Applications – Including JavaScript in HTML – HTML5 Form Controls and Validation - Document Object Model - DOM manipulation and events - Event Handlers

Unit 3
Overview of UI Frameworks – User Interface Design Concepts in Web Development – Accessibility - Introduction to Electron - Overview of Electron - Setting up an Electron project - Creating a basic desktop application with Electron - Object communication - Introduction to other popular frameworks and libraries (e.g., JavaFX, WPF, GTK).

Textbook(s)
Jennifer Kyrnin, Julie Meloni, "Sams Teach Yourself HTML, CSS, and JavaScript All in One", Third Edition, Pearson Education, Inc., 2019.

Reference(s)
Jennifer Niederst Robbin, "LEARNING WEB DESIGN A BEGINNER'S GUIDE TO HTML, CSS, JAVASCRIPT, AND WEB GRAPHICS", Fifth Edition, O'Reilly Media, Inc., 2018.
Jessica Minnick, "Responsive Web Design with HTML 5 and CSS", 9th Edition, Cengage Learning, Inc., 2021.
Electron JS.
https://www.electronjs.org/docs/latest
https://www.electronforge.io/
https://www.electronjs.org/fiddle

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester - lab-based examination

23MEE115	MANUFACTURING PRACTICE	L-T-P-C:0-0-3-1

Course Objectives

- Imparting the knowledge of general safety procedures that should be observed on the shop floor.
- Use modelling software to design and print simple geometry for additive manufacturing processes.
- Hands-on experience - arc welding and soldering operations.
- Use of different tools and accessories used for basic manufacturing processes.
- Familiarize with the essential pneumatic and electro-pneumatic components for automation and design pneumatic / electropneumatic circuits for the given simple application
- Understanding the functioning of various sub-systems of automobiles, such as the power train, steering system, suspension system, and braking system and realize the importance of recent developments in automotive technologies.

Course Outcomes

CO1: Practice safety procedures in a shop floor environment.
CO2: Select appropriate tools and methods for basic manufacturing processes.
CO3: Build simple geometries using additive manufacturing process.
CO4: Perform basic metals joining using welding and soldering.
CO5: Design, simulate and test simple pneumatic and electro pneumatic circuit for automation application.
CO6: Understand the functioning of automotive systems and realize the importance of recent developments in automotive technologies.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1			1				1		2
CO2	2	3				2				2		3
CO3	2	2	1		3	1	1			2	1	3
CO4	2	3	2							2	1	3
CO5	3	2	2		3					2	1	3
CO6	3	2	2		3					3	1	3

Syllabus

1. **Additive Manufacturing Laboratory –12 hours**

Introduction to digital manufacturing. Introduction to Additive Manufacturing - types – additive manufacturing applications - Materials for 3D printing, CAD Modelling for Additive manufacturing, Slicing and STL file generation- G code generation - 3D printing of simple geometries.

2. **Mechanical Engineering Laboratory –12 hours**

Study of tools and equipment used for basic manufacturing processes.
Manual arc welding practice for making Butt and Lap joints - Soldering Practice
Introduction to Machine Tools and Machining Processes

3. **Automation lab –12 hours**

Design, simulate and test pneumatic and electro-pneumatic circuits. Introduction to PLC –PLC programming for automation applications.

4. **Automobile Engineering lab –9 hours**

Overview of automobiles – components –functioning of various sub-systems; Power train, steering system, suspension system and braking system. Introduction to electric vehicles, hybrid vehicles, alternate fuels. Introduction to E Mobility.

Reference(s)
Lab Manual
Evaluation Pattern: 80:20

Assessment	Internal	End Semester
CA	60	
End Semester		40

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

Course Objectives

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.

Course Outcomes

CO1: Will be able to recognise the call of Upanishads and outstanding personalities for confronting the wicked in the real world while admiring the valour, pursuit and divinity in both classical and historical female characters of India.

CO2: Will get introduced to Acharya Chanakya, his works, and his views on polity and nation to find synchrony between public and personal life, alongside understanding India's cultural nuances and uniqueness concerning the comprehension of God across major global communities.

CO3: Will be able to appreciate Bhagavad Gita as the source of the Indian worldview through the various Yogic lessons enshrined in it, making it one of India's numerous soft powers, and also understand the faith-oriented mechanism of preserving nature.

CO4: Will be informed about the enormous contribution of Indian civilisation over two and a half millennia to humanity and develop awareness about India's approach toward science, devoid of dogmas and rooted in humanism.

CO-PO- Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			1	2				2						
CO2	2	1				1		3	1					
CO3	2		1	2	1	1		3						
CO4	2			3				3	2					

Syllabus

Face the Brutes, Role of Women in India, Acharya Chanakya, God and Iswara, Bhagavad Gita: From Soldier to Samsarin to Sadhaka, Lessons of Yoga from Bhagavad Gita, Indian Soft powers, Preserving Nature through Faith, Ancient Indian Cultures (Class Activity), Practical Vedanta, To the World from India, Indian Approach to Science.

Textbook(s)

"Glimpses of Glorious India", In house publication (In print).

Reference(s)

The Kautilya Arthashastra by Chankaya – Translation with critical and explanatory note by R P Kangle – Motilal Banarasidass Publishers- 1972.

Chanakya Neeti – Strategies for success – Radhakrishnan pillai – Jaico Publishing house -2020.

Universal Message of the Bhagavad Gita: An exposition of the Gita in the Light of Modern Thought and Modern Needs. - Swami Ranganathananda, Advaita Ashrama Belur Math, 2000.

A Concise History Of Science In India – D M Bose, S N Sen, B V Subbarayappa,The Indian National Science Academy 1971.

Indian Culture and India's Future – Michel Danino - D.K. Printworld (P) Ltd -2011.

Evaluation Pattern: 50:50

Assessment	Internal	End Semester
Term Project	30	
Mid-term	30	
End Semester		40

SEMESTER III

23MAT206	OPTIMIZATION TECHNIQUES	L-T-P-C: 3-0-2-4

Course Objectives

- To understand the concept of search space and optimality for solutions of engineering problems.
- To understand some computation techniques for optimizing single variable functions.
- To understand various computational techniques for optimizing severable variable functions.

Course Outcomes

CO1: Understand different types of Optimization Techniques in engineering problems. Learn Optimization methods such as Bracketing methods, Region elimination methods, Point estimation methods.
CO2: Understand Optimizations Techniques in single variable functions.
CO3: Understand the optimality criteria for the multivariable optimizations.
CO4: Understand Optimizations Techniques in multi variable functions.
CO5: Understand constrained optimization techniques and Kuhn-Tucker conditions.

CO-PO Mapping

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

Syllabus

Unit 1
Introduction to optimization: classical optimization, Optimality criteria – Necessary and sufficient conditions for existence of extreme point.
Direct search methods: unidirectional search, evolutionary search method, simplex search method, Introduction, Conditions for local minimization. One dimensional Search methods: Golden search method, Fibonacci method, Newton's Method, Secant Method, Remarks on Line Search Sections. Hook-Jeeves pattern search method.

Unit 2
Gradient-based methods- introduction, the method of steepest descent, analysis of Gradient Methods, Convergence, Convergence Rate. Analysis of Newton's Method, Levenberg-Marquardt Modification, Newton's Method for Nonlinear Least-Squares.
Conjugate direction method, Introduction, The Conjugate Direction Algorithm, The Conjugate Gradient Algorithm for Non-Quadratic Quasi Newton method.

Unit 3
Nonlinear Equality Constrained Optimization- Introduction, Problems with equality constraints Problem Formulation, Tangent and Normal Spaces, Lagrange Condition
Nonlinear Inequality Constrained Optimization -Introduction **-** Problems with inequality constraints: Kuhn-Tucker conditions.

Lab Practice Problems: Single and multivariable optimizations. Implementation of iterative methods.

Case studies

Textbook(s)
Edwin K.P. Chong, Stanislaw H. Zak, "An introduction to Optimization", 2nd edition, Wiley, 2013.

Reference(s)
S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.
Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2002.

Lab Experiments:

1. Identifying definiteness of matrices using eigenvalues and use of Hessian matrix to identify concavity of the surfaces (revision from Calculus and Linear Algebra)
2. Implementation of Golden Section Search, Fibonacci search for single variable optimization problems
3. Evaluation of ordinary and partial derivatives numerically (in excel/MATLAB)
4. Implementation of Secant method and Newton's method for single variable optimization problems
5. Implementation of evolutionary search method for multivariable optimization problems
6. Implementation of Simplex search method for multivariable optimization problems
7. Implementation of Hooke-Jeeve's Pattern Search method for multivariable optimization problems
8. Implementation of Newton's method for solving system of non-linear equations
9. Implementation of Newton's method for solving multivariable optimization problems
10. Identifying whether a constrained optimization problem is convex or not and solutions using 'cvx'

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Lab Practice, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23CSE205	DIGITAL ELECTRONICS	L-T-P-C: 3-0-0-3

Course Objectives

- To provide an understanding of basic building blocks of digital circuits
- To enable the understanding of Boolean algebra and logic function optimization
- To enable design of combinational and sequential circuits

Course Outcomes

CO1: Realize a given expression in terms of basic building blocks.
CO2: Minimize a given logic expression.
CO3: Design combinational circuits
CO4: Design Sequential circuits.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												2
CO2	3	2												2
CO3	3	3	2									2		2
CO4	3	3	2									2		2

Syllabus

Unit 1
Introduction to logic circuits - Variables and functions, inversion - Truth tables - Logic gates and Networks - Boolean algebra - Synthesis using gates - Design examples - Optimized implementation of logic functions - Karnaugh map - Strategy for minimization - Minimization of product of sums forms - Incompletely specified functions - Multiple output circuits - Tabular method for minimization.

Unit 2
Combinational circuit building blocks - Number representation and arithmetic circuits: Addition of unsigned numbers - Signed numbers - Fast adders - Multiplexers - Decoders - Encoders - Code converters - Arithmetic comparison circuits.

Unit 3
Sequential circuit building blocks - Basic latch - Gated SR latch - Gated D latch - Master slave and edge triggered - D flip-flops - T flip-flop - JK flip-flop, Registers, Asynchronous Counters, Synchronous Counters, Ring Counter and Johnson Counter, Synchronous sequential circuits - Basic design steps - State assignment problem – Design of Mealy and Moore state models.

Textbook(s)

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.
R. D. Sudhakar Samuel, "Logic Design: A Simplified Approach", Sanguine Technical Publishers, Edition 1, 2006

Reference(s)

M Morris Mano and Michael D Ciletti, "Digital Design with Introduction to the Verilog HDL", Pearson Education, Fifth Edition, Fifth Edition, 2015
John F. Wakerly, "Digital Design Principles and Practices", Fourth Edition, Pearson Education, 3rd Ed, 2008.
Donald D Givone, "Digital Principles and Design", Tata McGraw Hill Publishing Company Limited, 2003.

Evaluation Pattern: 60:40

Assessment	Internal	External
Mid Sem Examination	30	
*Continuous Assessment (CAT)	30	
End Semester		40

*CAT includes Quizzes, Assignments and Tutorials

23CSE201	PROCEDURAL PROGRAMMING USING C	L-T-P-C: 3-0-2-4

Course Objectives

This course aims to provide the procedural/imperative programming principles to the students through C programming language. The language will be taught in the context of Physical Computing using Arduino.

Course Outcomes

CO1: Understand the typical programming constructs: data (primitive and compound), control, modularity, recursion etc. thereby to understand a given program.
CO2: Analyse a given program by tracing, identify coding errors and debug them.
CO3: Apply the programming constructs appropriately and effectively while developing computer program.
CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications.

CO-PO Mapping

PO/PSO & CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	2
CO2	2	1	1	-	2	-	-	-	-	-	-	-	2	2
CO3	2	2	2	-	2	-	-	-	-	-	-	-	2	2
CO4	3	2	3	-	3	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Review of Physical Computing, Understanding Arduino Hardware and Software Architecture - Verifying Hardware and Software - Loading and Running your First Program

Introduction to C - Structure of C programs - Data types - I/O - control structures.

Unit 2
Arrays - Functions - Storage Classes and Scope - Recursion - Pointers: Introduction, pointer arithmetic, arrays and pointers, pointer to functions, dynamic memory allocation.

Unit 3
Structures, Unions and Data Storage - Strings: fixed length and variable length strings, strings and characters, string manipulation functions - Files and Streams - C Preprocessor - Command line arguments.

Textbook(s)

Jack Purdum, "Beginning C for Arduino", Second Edition, APress, 2015.

Reference(s)

Peter Linz and Tony Crawford, "C in a Nutshell: The Definitive Reference", Second Edition, O'Reily Media, 2016.
Jens Gustedt, "Modern C", Manning Publications, 2019.
Robert C. Seacord, Effective C - "An Introduction to Professional C Programming", No Starch Press, 2020.
Daniel Gookin, "Tiny C Projects", Manning Publications, 2022.

Evaluation Pattern - 70:30

Assessment	Internal	External
Mid Term Examination	20	-
Continuous Assessment – Theory (CAT)	10	-
Continuous Assessment – Lab (CAL)	40	-
**End Semester	-	30 (50 Marks – 2 hours)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination

23CSE202	DATABASE MANAGEMANT SYSTEMS	L-T-P-C: 3-0-2-4

Course Objectives

- This course aims to understand the concept of database design, database languages, database-system implementation, and maintenance.

Course Outcomes

CO1: Design ER models for real world databases
CO2: Apply the principles of Normalization to improve the design of databases for real world applications.
CO3: Formulate queries over relational databases using SQL and PL/SQL
CO4: Apply the principles of indexing, transaction processing and concurrency control.
CO5: Apply the concepts of NoSQL databases.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	2	2	1	-	3	3
CO2	3	3	3	3	3	-	-	-	2	2	1	-	3	3
CO3	2	2	2	2	2	-	-	-	2	2	1	-	3	3
CO4	1	1	2	2	2	-	-	-	-	-	-	-	2	2
CO5	1	1	2	2	2	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Introduction: Overview of DBMS fundamentals – Overview of Relational Databases and Keys. Relational Data Model: Structure of relational databases – Database schema. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas - Entity Relationship Design Issues - Extended E-R Features – Alternative E-R Notations.

Unit 2
Relational Database Design: Features of Good Relational Designs - Atomic Domains and 1NF - Decomposition using Functional Dependencies: 2NF, 3NF, BCNF and Higher Normal Forms. Functional Dependency Theory - Algorithm for Decomposition – Decomposition using multi-valued dependency: 4NF and 4NF decomposition. Database design process and its issues. SQL: review of SQL – Intermediate SQL – Advanced SQL.

Unit 3
File Organization – Indexing and Hashing - Storage Structure - Transactions: Transaction concepts- ACID Properties – Serializability – Recoverable schedules, Cascadeless schedules. Need for Concurrency -Locking Protocols- Deadlock and Recovery. Overview and applications of NoSQL databases – MongoDB, Neo4j/GraphDB.

Textbook(s)
Silberschatz A, Korth HF, Sudharshan S. "Database System Concepts". Seventh Edition, TMH publishing company limited; 2019.

Reference(s)
Garcia-Molina H, Ullman JD, Widom J. "Database System; The complete book". Second Edition, Pearson Education India, 2011.
Elmasri R, Navathe SB. "Fundamentals of Database Systems". Seventh Edition, Addison Wesley; 2017.
Ramakrishnan R, Gehrke J. "Database Management Systems". Third Edition, TMH; 2003.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination

23CSE203	DATA STRUCTURES AND ALGORITHMS	L-T-P-C: 3-1-2-5

Pre-Requisite(s): 23MATXXX Discrete Mathematics

Course Objectives

- This course aims to provide the students, an in-depth understanding of structure and implementation of the common data structures used in computer science.
- It imparts the ability to solve problems by choosing and applying the right data structures.
- It also imparts the ability to improve the efficiency of programs by applying the right data structures.

Course Outcomes

CO1: Understand the concept and functionalities of Data Structures and be able to implement them efficiently.
CO2: Identify and apply appropriate data structures and their libraries to solve problems and improve them efficiency
CO3: Analyze the complexity of data structures and associated algorithms.
CO4: Analyze the impact of various implementation and design choices on the data structure performance.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		3			1		1			3	1
CO2	3	3	1	2				1		1			3	1
CO3	1	3	1	2				1		1			3	1
CO4	2	2	1	2	3			1		1			3	1

Syllabus

Unit 1
Introduction to Data Structures: Need and Relevance - Abstract Data Types and Data Structures - Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs – Space Bounds, recursion- linear, binary, and multiple recursions. Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Stack Applications. Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue, applications.

Unit 2
Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT. Skip Lists - Implementation - Complexity.

Unit 3
Search trees – Binary search tree, AVL tree and its rotation– Segment Trees - B-Trees. Implementation. External Memory Sorting and Searching. Graphs: ADT- Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

Persistent data structures, fusion trees, Bloom filter, Game Trees (Case Study)

Textbook(s)
Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Python++", John Wiley publication, 2013.

Reference(s)

1. *Michael T Goodrich and Roberto Tamassia and Michael H Goldwsasser, "Data Structures and Algorithms in Java", Fifth edition, John 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.*
4. *Dinesh P. Mehta, Dinesh P. Mehta, Sartaj Sahni, "Handbook of Data Structures and Applications", Chapman and Hall/CRC, 2004.*
5. *George Heineman Gary Pollice, Stanley Selkow, "Algorithms in a Nutshell", O'Reilly; 2nd edition, 2016.*

Evaluation Pattern: 70:30

Assessment	**Internal**	**End Semester**
Midterm	20	
*Continuous Assessment Theory (CAT)	20	
*Continuous Assessment Lab (CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination

23CSE285	DIGITAL ELECTRONICS LABORATORY	L-T-P-C: 0-0-3-1

Course Objectives

• To provide hands-on experience in realizing simple logic expressions
• To demonstrate the power of logic function optimization
• To enable the implementation of combinational and sequential circuits.

Course Outcomes

CO1: Use datasheets & simulation tools effectively
CO2: Realize simple logic circuits
CO3: Design & implement combinational circuits
CO4: Design & implement sequential circuits

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3				2	2		2		2
CO2	3								2	2				2
CO3	3	3	2						2	2		2		2
CO4	3	3	2						2	2		2		2

Syllabus

1. Logic Gates: Implement logic gates using NAND / NOR.
2. Boolean functions: using logic gates
3. Combinational circuits: Mux, De-Mux, Code Converters, Adders & Subtractors
4. Sequential Circuits: Flip-Flops, Counters, State Machines

Experiments

1. Verification of Basic Logic Gates.
2. Realization of Basic Gates using Universal Logic Gates.
3. Simplification and Realization of a given Boolean Expression i) Using basic gates ii) SOP Using NAND gates only iii) SOP Using NOR gates only iv) POS Using NAND gates only v) POS Using NOR gates only and vi) Compare and analyze the above implementations
4. Design and verification of Adders and Subtractors.
5. Design and verification of Parallel Adder / Subtractor.
6. Design and verification of Binary to Gray code converter and vice versa.
7. Design and verification of BCD to Excess-3 code converter and vice versa.
8. Design and verification of 2-bit Magnitude Comparator.
9. Design and verification of Multiplexers
10. Implementation and verification of Half adder, full adder, half subtractor and full subtractor using multiplexers.
11. Design and verification of Flip-flops (D, T and JK flipflop).
12. Design and verification of shift Registers.
13. Design and verification of Ring and Johnson Counters.
14. Design and verification of 4-bit asynchronous Up and Down Counters

Text Book(s)

Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital logic with Verilog Design", Tata McGraw Hill Publishing Company Limited, Special Indian Edition, 2007.

Reference(s)

John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Fourth Edition, 2008.
K A Navas, "Electronic Lab Manual" – Volume 1, Fifth Edition, Prentice Hall of India, 2015.
M Morris Mano and Michael D Ciletti, "Digital Design with Introduction to the Verilog HDL", Pearson Education, Fifth Edition, Fifth Edition, 2015

Evaluation Pattern: 80:20

Assessment	Internal	External
Mid Sem Examination	20	
*Continuous Assessment Laboratory (CAL)	60	
End Semester		20

*CAL includes Lab Evaluations, Assignments

23LSE201	LIFE SKILLS FOR ENGINEERS I	L-T-P-C: 1 0 2-P/F

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

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Support them in developing their problem solving and reasoning skills
- Facilitate the enhancement of their communication skills

Course Outcomes

CO1: Soft Skills: To develop greater morale and positive attitude to face, analyse, and manageemotions in real life situations, like placement process.
CO2: Soft Skills: To empower students to create a 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 employ the most suitable methods to solve questions on arithmetic and algebra.
CO4: Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5: Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.
CO6: Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

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
CO3		3		2								
CO4		3		2								
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.

Aptitude

Problem Solving I

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

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of wordanalysis 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 (**Basic**): Help students learn the usage of structural words and facilitate students to identifyerrors and correct them.
Reasoning: Stress the importance of understanding the relationship between words through analogy questions.
Speaking Skills: Make students conscious of the relevance of effective communication in today's worldthrough various individual speaking activities.

Reference(s):

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern: 50:50

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

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

SEMESTER IV

23MAT216	PROBABILITY AND RANDOM PROCESSES	L-T-P-C: 3-0-2-4

Course objectives

- To understand the concepts of basic probability and random variables.
- To understand some standard distributions and apply them to some problems.
- To understand the concepts of random process, stationarity, and autocorrelation functions.
- To understand Markov process and Markov chain and related concepts.

Course Outcomes

CO1: Understand the basic concepts of probability and probability modeling.
CO2: Understand statistical distributions of one- and two-dimensional random variables and correlations.
CO3: Understand the basic concepts of stochastic processes and stationarity.
CO4: Understand the purpose of some special processes.
CO5: Understand spectrum estimation and spectral density function.

CO-PO Mapping

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

Syllabus

Unit 1
Review of probability concepts - conditional probability- Bayes theorem. Random Variable and Distributions: Introduction to random variables – discrete and continuous random variables and their distribution functions- mathematical expectations – moment generating function and characteristic function.

Unit 2
Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (moment generating function, mean, variance and simple problems) – Chebyshev's theorem.

Unit 3
Stochastic Processes: General concepts and definitions - stationary in random processes - strict sense and wide sense stationary processes - autocorrelation and properties- special processes – Poisson points, Poisson and Gaussian processes and properties- systems with stochastic inputs - power spectrum- spectrum estimation, ergodicity –Markov process and Markov chain, transition probabilities, Chapman Kolmogrov theorem, limiting distributions classification of states. Markov decision process.

Lab Practice Problems: Implementation of various statistical measures like, mean, mode and deviations. Linear regression and correlations. Implementation of statistical distributions and Markovian models.

Textbook(s)
Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", (2005) John Wiley and Sons Inc.
A. Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.

Reference(s)
J. Ravichandran, "Probability and Random Processes for Engineers", First Edition, IK International, 2015.
Scott L. Miller, Donald G. Childers, "Probability and Random Processes", Academic press, 2012.

Lab Experiments:

1. Finding statistical measures like mean, variance, standard deviation, mode and moments for given data
2. Use of 'pdf','cdf','icdf' commands for finding probabilities if random variable follows Binomial, Poisson, uniform, exponential and normal distributions
3. Generation of sample data from populations with various discrete distributions
4. Generation of sample data from populations with various continuous distributions
5. Multilinear Regression
6. Evaluation of Covariance and Correlation using excel/MATLAB
7. Multinomial and multinormal distributions
8. Generation of Multivariate Data

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessments (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Lab Practice, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23CSE211	DESIGN AND ANALYSIS OF ALGORITHMS	L-T-P-C: 3-0-2-4

Pre-Requisite(s): 23CSEXXX Data structure and Algorithms, 23MATXXX Discrete Mathematics

Course Objectives

This course aims to provide the fundamentals of algorithm design and analysis, specifically in terms of algorithm design techniques, application of these design techniques for real-world problem solving and analysis of complexity and correctness of algorithms.

Course Outcomes

CO1: Evaluate the correctness and analyze complexity of algorithms.
CO2: Implement various algorithmic design techniques and solve classical problems.
CO3: Design solutions for real world problems by identifying, applying and implementing appropriate design techniques.
CO4: Design solutions for real world problems by reducing to classical problems.
CO5: Analyze the impact of various implementation choices on the algorithm complexity.

CO-PO Mapping

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	1			1		1			3	2
CO2	3	2	2		0			1		1			3	2
CO3	3	2	3	2	0			1		1			3	2
CO4	2	2	3	2	1			1		1			3	2
CO5	2	2	3	1	1			1		1			3	2

Syllabus

Unit 1
Introduction and Review-Review of Asymptotic notation: motivation and types of notations. Recurrence relations and methods to solve them: Recursion tree, substitution, Master Method. Review of Sorting: Bubble –Insertion – Selection – Bucket – Heap, Comparison of sorting algorithms, Applications. Graph Algorithms – Graph Traversal: Applications of BFS: distance, connectivity and connected components and cycles in undirected graphs. Applications of DFS: Topological sort, cycles in directed graphs, Biconnected Components and Strong Connectivity. Path algorithms: shortest path algorithms (along with analysis) SSSP: Bellman Ford. APSP: Floyd Warshall's. Review of Minimum Spanning Tree (with analysis and applications).

Unit 2
Divide and Conquer: Merge sort, Quick Sort, Quick Select and Binary search type strategies, Pivot based strategies – Long integer multiplication – Maximum sub array sum - Closest Pair problem, convex hull etc. as examples. Greedy Algorithm - Introduction, Fractional Knapsack problem, Task Scheduling Problem, Huffman coding etc as examples. Dynamic Programming: Introduction, Fibonacci numbers, 0-1 Knapsack problem, Matrix chain multiplication problem, Longest Common Subsequence, Optimal Binary search Tree and other problems including problems incorporating combinatorics as examples.

Unit 3
Backtracking, Branch and Bound 0-1 Knapsack, N- Queen problem, subset sum as some examples. String Matching: Rabin Karp, Boyer Moore, KMP. Network Flow and Matching: Flow Algorithms Maximum Flow – Cuts Maximum Bipartite Matching. Introduction to NP class: Definitions P, NP, SAT problem NP complete, NP hard, Examples of P and NP.
Scalable algorithms: Blind search, heuristic searching algorithms, hill climbing algorithm, gradient descent algorithm, Parallel algorithms

Textbook(s):
Michael T Goodrich and Roberto Tamassia, "Algorithm Design and Applications ", John Wiley & Sons Inc, 2014
Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, "Introduction to Algorithms", Fourth Edition, Prentice Hall of India Private Limited, 2022

Reference(s)

Dasgupta S, Papadimitriou C and Vazirani U, "Algorithms", Tata McGraw-Hill, 2009.
Jon Kleinberg, Eva Tardos. "Algorithm Design". First Edition, Pearson Education India; 2013.
McConnell, J. J. "Analysis of Algorithms: An Active Learning Approach", 2nd edn. Jones & Bartlett Learning, 2001
Russell, Stuart J. "Artificial intelligence a modern approach". Pearson Education, Inc., 2010.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination

23CSE212	PRINCIPLES OF FUNCTIONAL LANGUAGES	L-T-P-C: 2-0-2-3

Pre-requisite(s)
The students must have learnt programming language(s) in either of the programming paradigms – Imperative and/or Object-oriented.

Course Objectives
The objective of this course is to open one's mind to different way of solving real-world problems with *functional* style as the primary reference against *imperative* and *object-oriented* paradigms. In fact, the more tools' students have while solving real-world problems, the better they will be in picking the best tool for the job. The course will also help students gain different programming language properties which will be helpful for them when they explore new programming languages.

Course Outcomes

CO1: Apply functional programming principles while designing solutions to problems and developing functional programs.
CO2: Formulate generic abstractions with higher order procedures while solving problems.
CO3: Formulate abstractions with data especially using lists and infinite data structures like streams.
CO4: Apply functional programming principles while developing solutions in contemporary languages.

CO-PO Mapping

PO/PSO & CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	2	-	-	-	-	-	-	-	2	2
CO2	2	2	2	1	2	-	-	-	-	-	-	-	2	2
CO3	2	2	2	1	2	-	-	-	-	-	-	-	2	2
CO4	3	2	3	1	3	-	-	-	-	-	-	-	2	2

Syllabus

Unit 1
Why are there so many programming languages – Programming Paradigms: Imperative, Object-oriented, Functional etc. - language characteristics: compiled and interpreted, type system, static and dynamic type checking, grouping data and operations, information hiding and abstract data types etc.

Haskell Basics, Haskell Types, type classes, functions: guards, pattern matching and recursion, lambda functions, functional composition, lists and list comprehension, higher-order functions: currying etc.

Unit 2
Abstract Data Types, Lazy Evaluation, Streams, IO, Applicative Functors, monad, Real World applications.

Unit 3
Functional Principles in Contemporary Languages – avoiding state updating and control structures: encapsulation, comprehension, recursion – callable: named functions and lambdas, closures, multiple dispatch - lazy evaluation – higher order functions.

Textbook(s)

Richard Bird, "Thinking Functionally with Haskell", Cambridge University Press, 2014.

Reference(s)

Rebecca Skinner, "Effective Haskell - Solving Real-World Problems with Strongly Typed Functional Programming", Pragmatic Bookshelf, 2023.
Richard S. Bird and Jeremy Gibbons, "Algorithm Design with Haskell", Cambridge University Press, 2020.
David Mertz, "Functional Programming in Python", O'Reilly, 2015.
John De Nero, "Composing Programs". Online https://composingprograms.com/
Wampler Dean, "Functional Programming for Java Developers", O'Reilly, 2011.

Evaluation Pattern - 70:30

Assessment	Internal	External
Mid Term Examination	20	-
*Continuous Assessment – Theory (CAT)	10	-
Continuous Assessment – Lab (CAL)	40	-
**End Semester	-	30 (50 Marks - 2 hours)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination

23CSE213	COMPUTER ORGANIZATION AND ARCHITECTURE	L-T-P-C: 3-1-0-4

Course Objectives

- This course aims to make students, understand, analyse, and appreciate the basic principles, design choices, and trade-offs associated in the field of Computer Architecture.
- It describes overview of ARM architecture in terms of instruction set, data path and pipelining
- It introduces pipelining and memory systems in detail along with performance metrics for designing computer systems and what can be done to make it better and faster.

Course Outcomes

CO1: Understand the design principles of Instruction Set Architecture (ISA) by taking ARM as reference.
CO2: Understand the design of data and control path in Single Clock Cycle.
CO3: Understand the design of instruction execution using Multiple Clock Cycles and Analyze / Evaluate the performance of processors.
CO4: Understand Pipelined architecture and Design of multi-stage pipeline processor in ARM.
CO5: Apply the working principles of ALU, Memory and I/O in the design of processor.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	1		3								3	2
2	3	3	3	2									3	2
3	2	2	2		3								3	2
4	2	2	3	2									3	2
5	2	2	2	2	3	2	2						3	2

Syllabus

Unit 1
Overview and history of computer architecture, combinational vs sequential logic, hardware description languages (VHDL), physical constraints (gate delay, fan-in, fan-out, energy/power). Introduction to Instruction Set Architecture, Processor Architecture with example as ARM & Instruction Set, Single Cycle Datapath Design, Control Hardware, Computer Arithmetic, Floating Point Arithmetic, Design of ALU, Introduction and Performance of Computing system and role of performance.

Unit 2
Introduction to multicycle at a path, Instruction level parallelism, instruction pipelining, Pipelining Technique – Design Issues, Hazards: Structural Hazards, Data Hazards and Control Hazards, Static Branch Prediction, Dynamic Branch Prediction, pipeline hazards and advanced concepts in pipelining.

Unit 3
Storage systems, introduction to memory hierarchy: importance of temporal and spatial locality; main memory organization, cache memory: address mapping, block size, replacement, and store policies; virtual memory system: page table and TLB. External storage; IO fundamentals: handshaking, buffering, programmed IO, interrupt driven IO; Interrupt handling mechanism, Buses: protocols, arbitration. Introduction to modern processors like GPU and TPU, Parallel Processing.

Textbook(s)
J. L. Hennessy and D. A. Patterson (H and P), "Computer Organization and Design, Hardware-Software Interface", ARM Edition , Morgan Kaufmann Publishing Co., 2017.

Reference(s)
L. Hennessy and D. A. Patterson (H and P), "Computer Architecture, A Quantitative Approach", Fifth or Sixth edition, J, Morgan Kaufmann Publishing Co., 2019.

D. A. Patterson and J. L. Hennessy (P and H), "Computer Organization and Design, The Hardware/Software Interface", Fifth edition , Morgan Kaufmann Publishing Co., 2013.
J.P. Hayes, "Computer Architecture and Organization", Mc Graw Hill 2017
William Stallings, "Computer Organization and architecture – Designing for performance", 10th Edition, 2016, Pearson Education.

Evaluation Pattern: 50:50

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (CA)	30	
End Semester		50

*CA includes Quizzes and Tutorials

23CSE214	OPERATING SYSTEMS	L-T-P-C: 3-0-2-4

Course Objectives

- This course aims at introducing the structure and implementation of modern operating systems, virtual machines and their applications.
- It summarizes techniques for achieving process synchronization and managing resources like memory, CPU, and files and directories in an operation system.
- A study of common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes) will be done.
- It gives a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently.

Course Outcomes

CO1: Understand the architecture and system calls of OS
CO2: Understand and apply the algorithms for resource management and scheduling.
CO3: Analyze and Apply semaphores and monitors for classical and real-world synchronization scenarios.
CO4: Engage in independent learning as a team and implement OS functionalities on a simulated machine.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1		2								3	2
CO2	2	2	3	1	3								3	2
CO3	2	3	3	2									3	2
CO4	2	2	1	2	3				2				3	2

Syllabus

Unit 1
Operating systems Services
Overview – hardware protection, services, system calls, system structure, virtual machines. Process and Processor management. Process concepts, process creation, process scheduling, operations on process, cooperating process, inter-process communication. Multi-threading models – threading issues, thread types. CPU scheduling – scheduling algorithms.

Unit 2
Process and Memory Management
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. Memory management - swapping, contiguous memory allocation, paging and segmentation, segmentation with paging, virtual memory, demand paging, page replacement, thrashing.

Unit 3
File and Disk Management
File management - File systems, directory structure, directory implementation. Disk Management – storage structure, disk scheduling.
Case study: Implement OS functionalities on a simulated machine (For example: XOS or eXperimental Operating System)

Textbook(s)
Silberschatz A, Gagne G, Galvin PB. "Operating system concepts". Tenth Edition, John Wiley and Sons; 2018.

Reference(s)

Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", Pearson Education India; Fourth edition 2016.
Stevens WR, Rago SA. "Advanced programming in the UNIX environment". Second Edition, Addison-Wesley; 2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Case-study Reports.
**End Semester can be theory examination/ lab-based examination

23LSE211	LIFE SKILLS FOR ENGINEERS II	L-T-P-C: 1-0-2-2

Pre-requisite(s): An inquisitive mind, basic English language skills, knowledge of high schoollevel mathematics.

Course Objectives

- Assist students in inculcating Soft Skills and developing a strong personality.
- Help them improve their presentation skills.
- Aid them in developing their problem solving and reasoning skills.
- Facilitate them in improving the effectiveness of their communication.

Course Outcomes

CO1: Soft Skills: To develop greater morale and positive attitude to face, analyse, and manageemotions 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 employ the most suitable methods to solve questions on arithmetic and algebra.
CO4: Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.
CO5: Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.
CO6: Verbal: To be able to read texts critically and arrive at/ predict logical conclusions. To learn to organize speech and incorporate feedback in order to convey ideas with better clarity.

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
CO3		3		2								
CO4		3		2								
CO5										3		3
CO6									3	3		3

Syllabus

Soft Skills
Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication
Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience – using storytelling technique, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.

Aptitude
Problem Solving II
Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.
Logarithms, Inequalities and Modulus: Basics
Time and Work: Basics, Pipes & Cistern, and Work Equivalence.
Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races andCircular tracks.
Logical Reasoning: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams,Binary Logic, and Logical Connectives.

Verbal

Vocabulary: Aid students learn to use their vocabulary to complete the given sentences with the rightwords. Usage of more appropriate words in different contexts is emphasized.
Grammar (**Basic-intermediate**): Help students master usage of grammatical forms and enablestudents to identify errors and correct them.

Reasoning: Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.
Reading Comprehension (**Basics**): Introduce students to smart reading techniques and help themunderstand different tones in comprehension passages.
Speaking Skills: Make students be aware of the importance of impactful communication throughindividual speaking activities in class.
Writing Skills: Introduce formal written communication and keep the students informed about the etiquette of email writing.

Reference(s)

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern: 50:50

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 V

23CSE301	MACHINE LEARNING	L-T-P-C: 3-0-2-4

Course Objectives

Machine learning covers significant ground in various verticals – including image recognition, medicine, cyber security, facial recognition, business analytics etc. Study of ML lays a strong foundation for the study on NLP, Deep Learning, Reinforcement Learning, Graphical Models, AI, Predictive Analytics etc.

● The aim of this course is to provide foundational knowledge in machine learning.

● The students will learn to implement, train and validate the machine learning models and understand the recent algorithms in machine learning through case studies.

Pre-Requisite(s): 23MATXXX Linear Algebra, 23MATXXX Probability and Random Processes

Course Outcomes

CO1: Understand the fundamental concepts, issues and challenges of machine learning.
CO2: **I**mplement machine learning algorithms using programming tools and provide solution to real world applications.
CO3: Apply machine learning algorithms for parameter estimation or prediction problem.
CO4: Apply supervised learning techniques for classification problem and analyse their performance.
CO5: Apply un-supervised and ensemble learning techniques to solve a given problem.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2	3	1		3	3	3		3	3	3
CO3	3	2	2	2									3	3
CO4	3	2	2	2									3	3
CO5	3	2	2	2									3	3

Syllabus

Unit 1
Introduction to machine learning, Types of Machine learning, features, class boundary, Training, Validation & Testing, Generalization - underfit, regular fit and overfit; Loss /Cost function; Issues of Explainability, algorithmic bias, data and algorithmic privacy. Curse of Dimensionality, Dimensionality Reduction Techniques – Principal component analysis, Linear Discriminant Analysis, Feature selection – sequential & bi-directional. K-Nearest Neighbour classifier, Regression: Linear, logistic, introduction to Regularization- LASSO, Ridge. Classifier Performance metrics – precision, recall, accuracy, f-score, AUC, Regression Performance metrics –RMSE, MAPE, R2 Score.

Unit 2
Supervised learning: Decision Trees, Support vector machines, Naive Bayes, Markov model, Hidden Markov Model, Artificial Neural Network - Perceptron & MLP with learning algorithms, Parameter Estimation: MLE and Bayesian Estimate, Expectation Maximization.

Unit 3
Unsupervised learning- Clustering – hierarchical & agglomerative, K means algorithm, cluster evaluation – Elbow technique; Ensemble learning – Bagging and boosting- Adaboost, Random Forest. Introduction to Reinforcement learning. Implementation of machine learning algorithms on real world problems and analyze their performance by tuning hyper parameters.

Textbook(s)
Tom Mitchell, "Machine Learning". McGraw Hill; ISBN: 9781259096952, 9781259096952; 2017.

Reference(s)
Kevin P. Murphey. "Machine Learning", a probabilistic perspective. MIT Press, 2012.
Christopher M Bishop. "Pattern Recognition and Machine Learning". Springer 2010.
Richard O. Duda, Peter E. Hart, David G. Stork. "Pattern Classification". Wiley, Second Edition;2007.

Trevor Hastie, Robert Tibshirani, Jerome Friedman. "The Elements of Statistical Learning: Data Mining, Inference, and Prediction". Springer, 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials

*CAL – Can be Lab Assessments, Project, Case Study and Report

**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE302	COMPUTER NETWORKS	L-T-P-C: 3-1-2-5

Course Objectives

- This course introduces the fundamental principles of computer networks including important layers and protocols
- This course will focus on the most important layers including application layer, transport layer, network layer and link layer along with their functionalities.
- This course will help students to understand the design of the computer networks for real-time applications.

Course Outcomes

CO1: Understand the basic architectural components of computer networks and apply mathematical foundations to solve computational problems in computer networking.
CO2: Apply network application services, protocols and programming for real-world applications.
CO3: Analyze protocols for data transfer mechanisms, buffer management and flow handling mechanisms
CO4: Apply various routing protocols and analyze routing protocols in the event of changes in network topology
CO5: Apply error handling mechanisms and Analyze network access protocols for the design of Local Area Network
CO6: Understand concepts of virtualization and data centric networking.

CO-PO Mapping

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2									3	2
CO2	2	2	2		3				2	2			3	2
CO3	3	3	3	2	3								3	2
CO4	3	3	2	2	3				2	2			3	2
CO5	3	3	2	2					2	2			3	2
CO6	2	2	1		3								3	2

Syllabus

Unit 1
The Internet-The Network Edge, the Network Core, Network Topology, Types of Networks, Delay, Loss, and Throughput in Packet Switched Networks. Protocol Layers and their Service Models. Principles of Network Applications: The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, DNS, Peer-to-Peer Applications. Video streaming and Content Distribution Networks.

Unit 2
Introduction and Transport Layer Services: Multiplexing and demultiplexing, Connectionless Transport - UDP, Principles of Reliable Data Transfer.
Transport layer - Connection Oriented Transport - TCP, Principles of Congestion Control, TCP Congestion Control. Introduction Network Layer: Virtual Circuit and Datagram Networks, Inside a Router, The Internet Protocol (IP) - Forwarding and Addressing in the Internet, Routing Algorithms, Routing in the Internet, Broadcast and Multicast Routing.

Unit 3
The Link Layer and Local Area Networks - Introduction and Services, Error-Detection and Correction Techniques, Multiple Access Protocols - Link-Layer Addressing, Ethernet, Link-Layer Switches. Physical layer: basics of digital & analog signals, data communication, characteristics of media, signal, noise, attenuation, SNR.
Link Virtualization: A Network as a Link Layer, Multiprotocol Label Switching (MPLS), Introduction to Software Defined Networks,
Case Study: Data center Networking – Architecture and recent trends in Data center networking.

Textbook(s)
Kurose J F and Ross K W. "Computer Networking: A Top-Down Approach". Eighth Edition, Pearson Press, 2021.

Reference(s)
Tanenbaum A S. "Computer Networks". Sixth Edition, Pearson Education India; 2021.

Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Elsevier Science, 2021.
Forouzan B A. "Data Communication and Networking". Fourth Edition, Tata McGraw Hill; 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	20	
*Continuous Assessment (Lab) (CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination

23CSE303	THEORY OF COMPUTATION	L-T-P-C: 3-1-0-4

Course Objectives

- This course provides an overview of the problems that can be solved by various kinds of abstract machines such as finite state machines, pushdown automata and Turing machines.
- This course deals with how efficiently problems can be solved on a model of computation, using an algorithm.
- This course gives an overview on how a real-world problem could be formalized into a mathematical problem (computational model)

Course Outcomes

CO1: Analyse the properties of regular languages and construct finite state machines.
CO2: Understand the properties of context free languages and construct push down automata.
CO3: Understand the decidability of a problem and construct Turing machines for decidable problems.
CO4: Apply formal languages and automata for a real-world scenario.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO														
CO1	3	3	2	2				-	-	-	-	-	3	1
CO2	3	3	2	2				-	-	-	-	-	3	1
CO3	3	3	2	2				-	-	-	-	-	3	1
CO4	3	3	3	3	3	-	-	2	2	2	-	-	3	1

Syllabus

Unit 1
Finite State machines –Deterministic finite state machine – Non-Deterministic finite state machine- Equivalence of NFA and DFA –Minimization of Finite State Machine – Regular Expression - Regular Language – Properties of Regular Languages. Designing Finite automata for real world problems.

Unit 2
Context Free Grammar – Derivations and Parse Tree - Pushdown Automata – Variants of Pushdown automata – Equivalence between PDA and CFG - Context Free Languages – Properties of CFL – Normal Forms. Designing push down automata for real world problems.

Unit 3
Context Sensitive Language- Linear Bound Automata- Turing Machine – Variants of Turing Machine – Decidability- Post correspondence problem – Introduction to undecidable problems. Case study on formalizing real world decidable and undecidable problems.

Text Book(s)
Linz P, Susan H. Rodger. An introduction to formal languages and automata. Seventh edition, Jones and Bartlett Publishers; 2022.

Reference(s)
Hopcroft JE, Motwani R, Ullman JD. Introduction to Automata Theory, Languages and Computation. Third Edition, Pearson; 2014.
Sipser M. Introduction to the Theory of Computation. Third Edition Cengage Publishers; 2012.
Martin JC. Introduction to Languages and the Theory of Computation. Fourth Edition McGraw-Hill; 2010.

Evaluation Pattern: 50:50

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (CA)	30	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports

23CSE304	EMBEDDED SYSTEMS	L-T-P-C: 3-0-2-4

Pre-Requisite(s): 23CSEXXX Computer Organization and Architecture

- Through this course, the students will learn how microprocessors/ controllers work, microcontroller architecture basics, and how electronic gadgets are designed, developed, and built as embedded systems.
- This course emphasizes on learning by doing and building solutions to real-world problems using embedded systems.

Course Outcomes

CO1: Understand the fundamentals, functions, and architecture of embedded systems.
CO2: Develop applications making use of GPIOs and peripheral units using Embedded C.
CO3: Develop applications for the usage of Timers, Interrupts, and Debugging of embedded applications.
CO4: Design an embedded system using an ARM processor.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1										1	3	2
CO2	3	2	2	2				2	2	2		2	3	2
CO3	3	3	3	2	3			2	2	2		2	3	2
CO4	3	3	3	2	3			2	2	2		2	3	2

Syllabus

Unit 1
Basics of Embedded Systems – Definition, Characteristics, Architecture of Microprocessors: General definitions of computers, microprocessors, microcontrollers, and digital signal processors. Introduction to ARM Cortex M4 Microcontroller – Architecture – Registers – Reset, Memory. Operating modes – Addressing modes and operands. Instructions for memory access, logical, arithmetic, and shift operations. Introduction to Thumb ISA.

Unit 2
GPIO programming- GPIO Configuration, Interfacing IO devices and its type – LEDs, Switches, Buzzer, Seven Segment Display, LCD, Analog I/O interfacing - DAC and ADC, PWM, Real-Time Clock, I/O synchronization,

Unit 3
Interrupt structure - Vector interrupt table, Interrupt service routines – Edge triggered, Timer Periodic Interrupts, NVIC, SysTick timer Synchronous and asynchronous communication, UART interfacing. I2C & SPI-I2C-specification, Protocol configuration, I2C Peripherals. SPI Specification, Protocol configuration- Abstraction -- Moore and Mealy machines, quantitative and qualitative performance measurements. Testing and Debugging of embedded applications.

Textbook(s)
Jonathan W. Valvano."Embedded Systems: Introduction to ARM Cortex-M Microcontrollers". CreateSpace Independent Publishing Platform , 2016.

References
Furber SB. "ARM system-on-chip architecture", Pearson Education; 2000.
Ariel Lutenberg, Pablo Gomez, Eric Pernia. "A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers", ARM Education media, 2022
Joseph Yiu. "System-on-Chip Design with Arm Cortex-M Processors Reference Book", ARM Education media, 2019.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23LSE301	LIFE SKILLS FOR ENGINEERS III	L-T-P-C: 1-0-2-2

Pre-requisite(s): Willingness to learn, communication skills, basic English language skills,knowledge of high school level mathematics.

Course Objectives

- Help students understand corporate culture, develop leadership qualities and becomegood team players
- Assist them in improving group discussion skills
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively

Course Outcomes

CO1 - Soft Skills: To improve the inter-personal communication and leadership skills, vital forarriving 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 identify, investigate and arrive at appropriate strategies to solve questionson geometry, statistics, probability and combinatorics.
CO4 - Aptitude: To analyze, understand and apply suitable methods to solve questions on logical reasoning.
CO5 - Verbal: To be able to use diction that is more refined and appropriate 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.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									3	3	2	3
CO2										3	2	2
CO3		3		2								
CO4		3		2								
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. Beingenterprising. 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 ina group discussion. Personality traits evaluated in a group discussion. Initiation techniques andmaintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

Aptitude
Problem Solving III
Geometry: 2D, 3D, Coordinate Geometry, and Heights & Distance.
Permutations & Combinations: Basics, Fundamental Counting Principle, CircularArrangements, and Derangements.
Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes'Theorem.
Statistics: Mean, Median, Mode, Range, Variance, Quartile Deviation and Standard Deviation.
Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd man out, Coding
\& Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Verbal
Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs. **Grammar** (**Upper Intermediate-Advanced**): Train Students to comprehend the nuances of Grammarand empower them to spot errors in sentences and correct them.
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.
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.

Reference(s)

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
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: 50:50

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.

23LIV390	LIVE-IN-LABS I***	L-T-P-C: 3-0-0-3

Course Objectives

1. Understand the principles of Human Centered Design, Participatory Rural Appraisal, Sustainable Change Agents, Ethnographic Action Research and User Need Assessment.
2. Learn the various tools, techniques and templates used in the mentioned concepts to identify the challenges in the villages.
3. Design a sustainable technological intervention for the identified challenge.

Course Outcomes

On the successful completion of the Course, the student will be able to –
CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal
CO3: Identify and formulate the research challenges in rural communities
CO4: Design solutions using human centered approach

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3		3		1	1		3	3		3
CO2		3						3	3	3		
CO3		3					1		3	3		3
CO4	3		3				3	3	3	3		3

Syllabus

Unit 1
Participatory Rural Appraisal (PRA)
Concept, Principles and Philosophy of PRA. Scope and Dimensions of PRA. Important Tools for PRA. Application of PRA.

Unit 2
Human Centered Design I (HCD)
Fundamentals of Human Centered Design. Design Process. User Experience. User Research. Data Analysis. Ideation.

Unit 3
Sustainable Social Change
Case Study. Introduction. Understanding and identifying the Community Communication Channels

Textbook(s)
There are no required textbooks for this course; all articles, reports and research papers assigned as required reading will be shared with the students by Live-in-Labs® faculties.

Reference(s)

1. *Ramesh, Maneesha Vinodini, Renjith Mohan, and Soumya Menon. "Live-in-Labs: Rapid translational research and implementation-based program for rural development in India." In 2016 IEEE Global Humanitarian Technology Conference (GHTC), pp. 164-171. IEEE, 2016.*
2. *Kadiveti, Hemasagar, Sahithi Eleshwaram, Renjith Mohan, S. Ariprasath, Krishna Nandanan, SG Divya Sharma, and B. Siddharth. "Water Management Through Integrated Technologies, a Sustainable Approach for Village Pandori, India." In 2019 IEEE R10 Humanitarian Technology Conference (R10- HTC)(47129), pp. 180-185. IEEE, 2019.*
3. *Akella, Devi. "Learning together: Kolb's experiential theory and its application." Journal of Management & Organization 16, no. 1 (2010): 100-112.*
4. *Harith, J., Sreeram Kongeseri, Balu M. Menon, J. V. Sivaprasad, P. Aswathi, and Rao R. Bhavani. "Exploring Digital Tool for Participatory Rural Appraisal." International Journal of Pure and Applied Mathematics 119, no. 12 (2018): 2787-2810.*

5. *Vechakul, Jessica, "Human-Centered Design for Social Impact: Case Studies of IDEO.org and the International Development Design Summit." UC Berkeley Electronic Theses and Dissertations*
6. *Sustainable Development Strategies: A Resource Book. Organization for Economic Co-operation and Development, Paris and United Nations Development Program, New York.*
7. *Field Guide to Human-Centered Design. By IDEO.org. 1st Edition © 2015. ISBN: 978-0-9914063-1-9*

Evaluation Pattern

Assessment	**Marks**
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

23ENV300	ENVIRONMENTAL SCIENCE	P/F

Course Objectives

- To study the nature and facts about environment
- To appreciate the importance of environment by assessing its impact on the human world
- To study the integrated themes and biodiversity, pollution control and waste management

Course Outcomes

CO1: Ability to understand aspects of nature and environment.
CO2: Ability to analyze impact of environment on human world.
CO3: Ability to comprehend pollution control and waste management.

CO – PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO2	-	-	-	-	-	3	2	3	-	-	-	-	-	-
CO3	-	-	-	-	-	3	2	3	-	-	-	-	-	-

Syllabus

Unit 1
Overview of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related international conventions and treaties and regulations – Overpopulation – energy crisis – Water crisis – ground water hydrogeology – surface water resourcedevelopment.

Unit 2
Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land, thermal, noise).

Unit 3
Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

Textbook(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.

Evaluation Pattern: P/F

<table>
<tr><td rowspan="2">Assessments</td><td>Internal</td><td>External</td></tr>
<tr><td>20 (2 Assignments: 10 X 2)</td><td>80</td></tr>
<tr><td></td><td colspan="2">P/F</td></tr>
</table>

SEMESTER VI

23CSE311	SOFTWARE ENGINEERING	L-T-P-C: 3-0-2-4

Course Objectives

- This course addresses issues in the engineering of software systems and development using live case studies from industries.
- The objectives of this course are to introduce basic software engineering concepts; to introduce the Agile Software development process; hands-on training (experiential learning) using state-of-the-art tools to understand the concepts learnt in the class.
- The course helps students to be industry-ready in terms processes, tools and terminologies from agile and devops point of view

Course Outcomes

CO1: Understand process models and apply Agile methodologies for proficient software process management.
CO2: Apply requirement engineering principles to analyze, model, and validate requirements for effective software solutions.
CO3: Design and implement robust software architectures and intuitive user interfaces, following industry best practices.
CO4: Implement comprehensive testing strategies to ensure high software quality.
CO5: Utilize industry-standard tools and Scrum for efficient software project management and collaboration.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2										1		1	
CO2	2	3	2										2	1
CO3	3	1	3		3				3	3	1		2	1
CO4	2	2	3		3				3	3	1		2	1
CO5	2		3		3				3	3	1	2	3	2

Syllabus

Unit 1
Process Models – overview, Introduction to Agile, Agile Manifesto, principles of agile manifesto, over-view of Various Agile methodologies - Scrum, XP, Lean, and Kanban, Agile Requirements - User personas, story mapping, user stories, estimating and prioritizing stories, INVEST, acceptance criteria, Definition of Done, Release planning Key aspects of Scrum: roles - Product Owner, Scrum Master, Team, Manager in scrum and product backlog Scrum process flow: product backlog, sprints backlog, scrum meetings, demos. How sprint works: Sprint Planning, Daily scrum meeting, updating sprint backlog, Burn down chart, sprint review, sprint retrospective. Scrum Metrics- velocity, burn down, defects carried over.

Unit 2
Traditional process Models: Waterfall, incremental, evolutionary, concurrent. Requirements Engineering: Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model-Negotiation- Validation Requirements Modelling - building the analysis model, Scenario based methods, UML Models, Data Models. Design engineering Design concepts, Design models, software architecture, architectural styles and patterns, Architectural design: styles and patterns, architectural design, Refining architecture to components. Performing user interface Design-Golden Rules-User Interface Analysis and Design-Interface Analysis-Interface design steps.

Unit 3
Testing strategies and tactics: Unit testing, integration testing, validation and system testing, Devops.

Textbook(s)
Pressman R S, Bruce R.Maxim, "Software Engineering - A Practitioner's Approach". Eighth Edition, McGraw-Hill Education, 2019.

Reference(s)
Crowder JA, Friess S. "Agile project management: managing for success". Cham: Springer International Publishing; 2015.
Stellman A, Greene J. "Learning agile: Understanding scrum, XP, lean, and kanban". O'Reilly Media, Inc.; 2015.
Gregory J, Crispin L. "More agile testing: learning journeys for the whole team". Addison-Wesley Professional; 2015.

Rubin KS. “Essential Scrum: a practical guide to the most popular agile process”. Addison-Wesley; 2012.
Cohn M. “User stories applied: For agile software development”. Addison-Wesley Professional; 2004.

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Sprint Reviews, Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE312	DISTRIBUTED SYSTEMS	L-T-P-C: 3-0-2-4

Course Objectives

- This course aims to provide students with a thorough understanding of distributed systems, including models of computation, communication mechanisms, consistency and replication protocols, and fault tolerance and recovery mechanisms.
- Students will also learn about emerging trends in cloud and edge computing.
- By the end of the course, students will have the skills and knowledge to design and implement scalable, fault-tolerant, and secure distributed systems using various tools and technologies.

Course Outcomes

CO1: Understand the design principles in distributed systems and the architectures for distributed systems.
CO2: Apply various distributed algorithms related to clock synchronization, concurrency control, deadlock detection, load balancing, voting etc.
CO3: Analyze fault tolerance and recovery in distributed systems and algorithms for the same.
CO4: Analyze the design and functioning of existing distributed systems like edge and cloud systems and distributed file systems.
CO5: Implement different distributed algorithms over current distributed platforms

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	-	-	-	1	-	-	-	3	2
CO2	3	3	2	2	2	-	-	-	1	-	-	-	3	2
CO3	3	3	2	2	2	-	-	1	1	-	-	-	3	2
CO4	3	3	2	2	2	-	-	1	1	-	-	-	3	2
CO5	3	3	3	1	3	-	-	1	1	2	-	-	3	2

Syllabus

Unit 1
Models of computation: shared memory and message passing systems. Synchronous and asynchronous systems.
Communication in Distributed Systems: Remote Procedure Calls, Message Oriented Communications. Implementations over a simple distributed system. Cloud computing: cloud models and service models, Overview of Models, cloud deployment models. Edge computing: edge devices, fog computing, edge cloud computing. Current research trends: edge intelligence, edge security.

Unit 2
Global state and snapshot algorithms. Logical time and event ordering, clock synchronization. Distributed mutual exclusion, group-based mutual exclusion, leader election. Concurrency control, deadlock detection, termination detection. Consensus algorithms: Paxos, Raft, and their variants. Edge computing: edge intelligence algorithms, distributed inference, edge caching. Current research trends: distributed machine learning, blockchain, quantum computing.

Unit 3
Data centric consistency, client centric consistency, replica management, consistency protocols. Fault tolerance and recovery: basic concepts, fault models, agreement problems and their applications, commit protocols, voting protocols, check pointing and recovery. Distributed file systems: scalable performance, load balancing, and availability. Edge computing: edge data management, edge security, edge fault tolerance. Current research trends: edge AI for fault tolerance, hybrid cloud and edge architectures.

Case Studies: HDFS- Hadoop, Apache Helix, GoBeam, Folding@home, Apache Spark, Apache Storm, Flink, DynamoDB, Gizzard. Google File System. BigTable/HBASE, Google Spanner, Amazon Aurora, BlockChain, ETCD, ZooKeeper

Textbook(s)
George Coulouris, Jean Dollimore, and Tim Kindberg, "Distributed Systems: Concepts and Design", 5th Edition, Pearson, April 2011.

Ajay D. Kshemkalyani and Mukesh Singhal "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011
Kai Hwang, Jack Dongarra, Geoffrey Fox "Distributed and Cloud Computing From Parallel Processing to the Internet of Things", Morgan Kaufman, 2012

Reference(s)
Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley, 2011
Rajkumar Buyya, Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", Wiley, 2019
Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", 1st Edition, Pearson, 2013
Xin Sun and Amin Vahdat, "Edge Computing: A Primer", CRC Press, June 4, 2019.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)2	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT includes Quizzes and Tutorials
*CAL – Can be Lab Assessments, Project, Case Study and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE313	FOUNDATIONS OF CYBER SECURITY	L-T-P-C: 3-0-0-3

Course Objectives

- Develop a comprehensive understanding of cybersecurity fundamentals, including principles, models, and regulatory requirements, to establish a strong foundation in the field.
- Acquire practical knowledge and skills in identifying and mitigating vulnerabilities in software applications, networks, and systems, applying industry-standard practices and technologies.
- Understand the principles of security governance to be able to ensure compliance with industry best practices and legal requirements, and effectively manage security risks in organizations.

Course Outcomes

CO1: Understand the key concepts and principles of cybersecurity, including the CIA triad, attacks, and security fundamentals such as principle of least privilege and security models.
CO2: Develop practical skills in software development and application security, including input validation, authentication and authorization, browser, database, and file security principles.
CO3: Identify network security threats and apply appropriate security measures, incident response, disaster recovery, and business continuity plan to mitigate the impact of security breaches and ensure continuity of operations.
CO4: Understand the principles of security governance, risk and compliance (GRC), and identity and access management (IAM) to protect against unauthorized access to information systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2									2	2
CO2	3	3	3	3	2								3	3
CO3	3	3	3	2	2								3	3
CO4	3	3	2	2									3	3

Syllabus

Unit 1
Fundamentals of Cybersecurity - Introduction to Cybersecurity: CIA triad – attacks - cybersecurity fundamentals such as Principle of Least Privilege, Security Principles and Models, Introduction to cryptographic algorithms, types.

Unit 2
Practical Security Concepts with stress on Technologies used in Cybersecurity - Software Development and Application Security: OWASP Top 10 and CWE - Input Validation, Authentication - Authorization – Browser Security Principles – Same origin policy (SOP) - Database security principles – File Security principles – Directory traversal.

Unit 3
Network Security: Network Threat Landscape, Types of Network Attacks and Sources. Security Standards; Regulatory Requirements; Security Assessment; Digital Forensics; Incident Response, Disaster Recovery and Business Continuity Management; Security Governance, Risk and Compliance; Identity and Access Management (IAM).

Textbook(s)
William Stallings and Lawrie Brown. "Computer Security: Principles and Practice". Fourth Edition, Pearson, 2019
William Stallings. "Network Security Essentials: Applications and Standards". Pearson, 2017.
Bryan Sullivan and Vincent Liu. "Web Application Security: A Beginner's Guide". McGraw-Hill Education, 2011.

Reference(s)
John Sammons, "The Basics of Digital Forensics", Elsevier Science, 2011.
Ross J. Anderson. "Security Engineering: A Guide to Building Dependable Distributed Systems". Wiley, 2008.
Raef Meeuwisse. "Cybersecurity: The Beginner's Guide". John Wiley & Sons, Inc., 2017
P.W. Singer and Allan Friedman. "Cybersecurity and Cyberwar: What Everyone Needs to Know". Oxford University Press, 2014.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT - Can be Quizzes, Assignment, and Reports
*CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23CSE314	COMPILER DESIGN	L-T-P-C: 3-0-2-4

Pre-Requisite(s): 23CSEXXX Theory of Computation

Course Objectives

- This course aims at introducing the major concepts in the areas of programming language translation and compiler construction.
- The course emphasizes techniques that have direct application to the construction of customized compilers.
- The course briefly covers code optimization techniques and algorithms.

Course Outcomes

CO1: Apply theoretical concepts for the analysis of program structure and identify syntax errors.

CO2: Apply theoretical concepts to associate semantic information in the program structure and translate it into intermediate representations.

CO3: Implement language translation techniques in open-source tools.

CO4: Analyze the design of data structures for compile-time and run-time code generation.

CO5: Apply code optimization algorithms to improve the performance of the translated code.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2								3	2
CO2	2	3	2		2								3	2
CO3	2	3	3	3	3							3	3	2
CO4	2	3	3										3	2
CO5	2	3	3	3								2	3	2

Syllabus

Unit 1

Overview of Compilation: Compilers and Interpreters: Definition, Objectives, Structure, Overview of Translation. Scanners. Parsers: LL, LR and LALR. Compiler Front-End Development using ANTLR.

Unit 2

Context-Sensitive Analysis: Attribute Grammar, Ad Hoc Syntax Directed Translation. Intermediate Representations. Symbol Tables: Stacks, Hash Table.

Unit 3

Procedure Abstraction: Access Links. Introduction to Optimization: Local Value Numbering, Super local Value Numbering. Data Flow Analysis: Iterative Data-Flow Analysis, SSA. Control Flow Analysis: Eliminating Useless and Unreachable Code.

Textbook(s)

Cooper, Keith, and Linda Torczon, "Engineering a Compiler", Third Edition, Elsevier, 2022.

Reference(s)

Parr T. "Language implementation patterns: create your own domain-specific and general programming languages". Pragmatic Bookshelf; First Edition, 2010.

Mak R. "Writing compilers and interpreters: a software engineering approach". John Wiley & Sons; Third Edition, 2009.

Appel W Andrew and Jens Palesberg, "Modern Compiler Implementation in Java", Cambridge University Press, Second Edition, 2002.

Aho, Alfred V., Monica S. Lam, Ravi Sethi, and Jeffrey Ullman, "Compilers: Principles, Techniques and Tools", Prentice Hall, Second Edition, 2006.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	-
*Continuous Assessment (Theory) (CAT)	10	-
*Continuous Assessment (Lab) (CAL)	40	-
**End Semester	-	30 (50 Marks; 2 hours exam)

*CAT - Can be Quizzes, Assignment, and Reports
*CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination

23LSE311	LIFE SKILLS FOR ENGINEERS IV	L-T-P-C: 1-0-2-2

Pre-requisite(s): Self-confidence, presentation skills, listening skills, basic English languageskills, knowledge of high school level mathematics.

Course Objectives

- Help students prepare resumes and face interviews with confidence
- Support them in developing their problem-solving ability
- Assist them in improving their problem solving and reasoning skills
- Enable them to communicate confidently before an audience

Course Outcomes

CO1: Soft Skills: To acquire the ability to present themselves confidently and showcase theirknowledge, 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 applying suitable methods to solve questions on arithmetic, algebra and statistics.
CO4: Aptitude: To investigate, understand and use appropriate techniques to solve questionson logical reasoning and data analysis.
CO5: Verbal: To use diction that is less verbose and more precise and to use prior knowledge of grammar to correct/improve sentences.
CO6: Verbal: To understand arguments, analyze arguments and use inductive/deductivereasoning 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.

CO-PO Mapping

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

Syllabus

Soft Skills
Teamwork: 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

Problem Solving II

Sequence and Series: Basics, AP, GP, HP, and Special Series.
Data Sufficiency: Introduction, 5 Options Data Sufficiency and 4 Options Data Sufficiency.
Logical reasoning: Clocks, Calendars, Cubes, Non-Verbal reasoning and Symbol based reasoning.
Campus recruitment papers: Discussion of previous year question papers of all major recruiters ofAmrita Vishwa Vidyapeetham.
Competitive examination papers: Discussion of previous year question papers of CAT, GRE,GMAT, and other management entrance examinations.
Miscellaneous: Interview Puzzles, Calculation Techniques and Time Management Strategies.

Verbal

Vocabulary: Empower students to communicate effectively through one-word substitution. **Grammar**: Enable students to improve sentences through a clear understanding of the rules ofgrammar.
Reasoning: Facilitate the student to tap his reasoning skills through Syllogisms, critical reasoningarguments and logical ordering of sentences.
Reading Comprehension (**Advanced**): Enlighten students on the different strategies involved intackling reading comprehension questions.
Public Speaking Skills: Empower students to overcome glossophobia and speak effectively andconfidently before an audience.
Writing Skills: Practice formal written communication through writing emails especially composing job application emails.

References

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita VishwaVidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. A Modern Approach to Verbal Reasoning – R.S. Aggarwal
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
15. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
16. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
17. A Modern Approach to Logical Reasoning, R S Aggarwal.
18. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal

Evaluation Pattern: 50:50

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.

23LIV490	LIVE-IN-LABS II ***	L-T-P-C: 3-0-0-3

Pre-Requisite(s):

Students can enroll for Live-in-Labs® II course only if they have successfully completed Live-in- Labs® I course by meeting all the criteria set by the Live-in-Labs® team.

Course Objectives

1. Understand the principles of
    a. Advanced Human Centered Design
    b. Co-Design
    c. Social Change Management Models
    d. Project Management
    e. Prototyping
    f. Modelling
    g. Field Implementation.
2. Learn the various tools, techniques and templates used in the mentioned concepts to implement a sustainable intervention in the villages.
3. Creating awareness and training the villagers.

Course Outcomes

On the successful completion of the Course, the student will be able to –
CO1: Learn co-design methodologies and engage in a participatory manner to finalize a solution
CO2: Understand sustainable social change models and identify change agents in a community
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5: Prototype implementation of the solution

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3
CO5			1						3	3		

Syllabus

Unit 1
Co-design
Introduction to co-design. Benefits of co-design. Co-design process. Co-design tools.

Unit 2

Project Management
Introduction to Project Management. Project Triple Constraints. Difference between project and operation. Phases of Project Management. Project Planning.

Unit 3
Human Centered Design II (HCD)
Design Process. Design evaluation. Design implementation.

Textbook(s)

There are no required textbooks for this course; all articles, reports and research papers assigned as required reading will be shared with the students by Live-in-Labs® faculties.

Reference(s)

1. *Ramesh, Maneesha Vinodini, Renjith Mohan, and Soumya Menon. "Live-in-Labs: Rapid translational research and implementation-based program for rural development in India." In 2016 IEEE Global Humanitarian Technology Conference (GHTC), pp. 164-171. IEEE, 2016.*
2. *Sipos, Yona, Bryce Battisti, and Kurt Grimm. "Achieving transformative sustainability learning: engaging head, hands and heart." International Journal of Sustainability in Higher Education 9, no. 1 (2008): 68-86.*
3. *Moldan, Bedřich, Svatava Janoušková, and Tomáš Hák. "How to understand and measure environmental sustainability: Indicators and targets." Ecological Indicators 17 (2012): 4-13.*
4. *Lee, Yanki. "Design participation tactics: the challenges and new roles for designers in the co-design process." Co-design 4, no. 1 (2008): 31-50.*
5. *Mohan, Harish T., Krishna Nandanan, Renjith Mohan, Olamide Sadipe, Iona Williams, and Teja Potocnik. "Case Study on Co-Design Methodology for Improved Cook Stove Solutions for Rural Community in India." In 2019 IEEE R10 Humanitarian Technology Conference (R10-HTC)(47129), pp. 153-158. IEEE, 2019.*
6. *Liam J. Bannon, Pelle Ehn. 06 Aug 2012, Design from: Routledge International Handbook of Participatory Design Routledge*
7. *Sustainable Development Strategies: A Resource Book. Organization for Economic Co-operation and Development, Paris and United Nations Development Program, New York.*
8. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Project Management Institute*
9. *Field Guide to Human-Centered Design. By IDEO.org. 1st Edition © 2015. ISBN: 978-0-9914063-1-9*

Evaluation Pattern

Assessment	**Marks**
1. Proposed Implementation Presentation Round 1	**2**
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii.Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii.Testing & Evaluation	4
iv. Sustenance Model Implementation	4
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**105**

23CSE399	PROJECT – PHASE – I	L-T-P-C: 0-0-6-3

Course Objectives

- The initial stage of the academic project involves identification of a problem domain and demonstrating a sound knowledge on the chosen domain.
- This phase offers students an opportunity to delve into the state-of-the-art within their chosen domain.
- During this phase, students are empowered to identify real-world applications within their chosen domain of study. This enables them to gain insight into their own strengths and innovate problem statements that align with practical scenarios.

Course Outcomes

At the end of this course the students will be able to:
CO1: Identify ongoing developments in the chosen domain and demonstrate technical knowledge pertaining to the same.
CO2: Define a problem and carry out a thorough study on the chosen problem.
CO3: Identify the research gap in the chosen area and effectively summarize the research findings.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		1		3		3	3		2	3	3	3
CO2	2	3		1		2		3	3		2	3	3	3
CO3	2	3		1				3	3	3	2	3	3	3

Evaluation Pattern: 70:30
Internal Marks: 70
External Marks: 30

SEMESTER VII

23CSE401	FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE	L-T-P-C: 2-0-2-3

Course Objectives

This course introduces the various fundamental concepts of Artificial Intelligence, such as:

- To introduce classical AI, problem formulation and intelligent agents.
- To introduce techniques for problem solving by search, knowledge-representation and reasoning.
- To introduce game playing and algorithms associated with it.
- To introduce planning, acting, and multi-agent systems.

Course Outcomes

CO1: Understand the foundations of AI systems, intelligent agents, problems solving strategies and Ethics in AI.
CO2: Apply elementary principles of AI like search and game playing for problem solving.
CO3: Analyse real world problems under uncertainty and solve them using knowledge representation and reasoning.
CO4: Understand planning and decision making in intelligent systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	1	2	1	1		1	3	2
CO2	3	2	3	2	3			1	2	2		2	3	2
CO3	3	2	3	2	3			2	2	2		2	3	2
CO4	3	2	2	1	1	1	1	1	2	2	2	1	3	2

Syllabus

Unit 1
History and Foundations of AI, Introduction to AI and systems - search strategies, problem characteristics, system characteristics, Intelligent Agents – Agents and environments, nature of environments and structure of agents, Ethics in AI; Case study: Games and puzzles.

Unit 2
Problem Solving by Search: Informed search - Heuristic, Hill climbing, Best first search, A*, AO*, Approaches in knowledge representation, Game Playing - minmax algorithm, Alpha beta pruning, Swarm intelligence, cooperative learning – constrained and unconstrained problems; Case study - Example: Group of Drones.

Unit 3
Knowledge representation - Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge. Knowledge inference - Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory Case Study-Examples: Recommendation systems, Knowledge based systems in application areas of computer science, Decision support systems, prediction and warning systems.

Unit 4
Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Map building, Multi-Agent Planning; Case study - Examples: vacuum cleaner, washing machine.

Textbook(s)
Russell, Stuart, Jonathan, Norvig, Peter, Davis, Ernest. "Artificial Intelligence: A Modern Approach". United Kingdom: Pearson, 4th Edition, 2022
Deepak Khemani. "A First Course in Artificial Intelligence". McGraw Hill Education (India), 2017.

Reference(s)
Denis Rothman. "Artificial Intelligence by Example", Packt, 2nd Edition, 2018.
Rich and Knight, "Artificial Intelligence",3rd Edition, Tata Mc Graw Hill, 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination

23CSE498	PROJECT – PHASE II	L-T-P-C: 0-0-12-6

Course Objectives

- In this phase, the emphasis is on fine-tuning the problem statement through the insights obtained from the identification of any existing research gaps.
- This phase involves providing a detailed representation of the solution strategy, including modules and workflow, as well as designing the solution in terms of algorithms, diagrams, or models.
- This phase exposes the students to design-develop-debug cycle.
- The implementation of the solution is carried out in this phase.

Course Outcomes

At the end of this course the students will be able to:
CO1: Apply the insights from the problem analysis and literature survey to formalize the problem statement.
CO2: Design effective solution(s) for the identified problem.
CO3: Implement and verify the designed solution(s).

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		2				3	3	3	2	3	3	3
CO2	3	3	3	2	3			3	3	3	2	3	3	3
CO3	3	3	3	2	3			3	3	3	2	3	3	3

Evaluation Pattern: 70:30
Internal Marks: 70
External Marks: 30

23LAW300	INDIAN CONSTITUTION	L-T-P-C: P/F

Course Objectives

- To know about Indian constitution
- To know about central and state government functionalities in India
- To know about Indian society

Syllabus

Unit 1
Historical Background – Constituent Assembly of India – Philosophical Foundations of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for Citizens.

Unit 2
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

Unit 3
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

Text Book(s)
Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

Reference(s)
Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.

Evaluation Pattern: P/F

Online Examination - 100 marks

SEMESTER VIII

23CSE499	PROJECT – PHASE III	L-T-P-C: 0-0-12-6

Course Objectives

- This phase of the academic project requires the students to validate their solution through appropriate empirical studies.
- This phase trains the students towards critical data analysis of their experimental results towards validating their designed solution(s).
- This phase facilitates the enhancement of students' writing skills by means of their documentation.
- This phase presents an opportunity to promote the project idea through participation in contests, contribution in conferences, journals, and potentially pursuing a patent.

Course Outcomes

At the end of this course the students will be able to:
CO1: Formulate comprehensive design of experiments and execute simulation studies.
CO2: Analyze the experiment results quantitatively to validate the designed solution(s).
CO3: Document the complete problem solving process and effectively communicate the findings through presentation.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3		3	3	3	2	3	3	3
CO2	3	3	3	3	3	3		3	3	3	2	3	3	3
CO3					3			3	3	3	2	3	3	3

Evaluation Pattern: 70:30
Internal Marks: 70
External Marks:30

PROFESSIONAL ELECTIVES

Electives in Cyber Security

23CSE331	CRYPTOGRAPHY	L-T-P-C: 3-0-0-3

Course Objectives

- The course will cover how cryptography (symmetric and asymmetric) works, how security is analyzed theoretically, and how exploits work in practice.
- It will also present Cryptanalysis attacks against the cryptographic techniques, and attack models.

Course Outcomes

CO1: Understand classical cryptography techniques and apply cryptanalysis.
CO2: Analyze measures for securing cryptosystem.
CO3: Apply and analyze operations on Feistel and non-Feistel structures.
CO4: Apply asymmetric encryption techniques for securing messages.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								2	2	1
CO2	3	3	2	2								2	2	2
CO 3	3	3	3	3								2	2	2
CO4	3	3	2	3								2	3	2

Syllabus

Unit 1
Classical ciphers and cipher strength
Basics of number theory, Encryption and Decryption of monoalphabetic and polyalphabetic ciphers. Cryptanalysis. Perfect Secrecy-Information and Entropy - Source Coding, Channel Coding, and Cryptography - Product cryptosystems.

Unit 2
Symmetric Key Cryptography
Foundations of Modern Cryptography: Symmetric Cryptosystems: Substitution Permutation Networks - DES and Enhancements - AES and its Modes, Blowfish.

Unit 3
Asymmetric Key Cryptography
Foundations of Asymmetric Key Cryptography - RSA Cryptosystem - Attacks on RSA Discrete Logarithm Problem and related algorithms – El-Gamal Cryptosystem – Elliptic curve cryptography

Textbook(s)
Stallings W. "Cryptography and network security: principles and practice". Upper Saddle River: Pearson; 2018. Padmanabhan TR, Shyamala C K, and Harini N. "Cryptography and Security", First Edition, Wiley India Publications; 2011.

Reference(s)
Forouzan BA. "Cryptography & network security". McGraw-Hill, Inc.; 2007 Feb 28.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE332	INFORMATION SECURITY	L-T-P-C: 3-0-0-3

Course Objectives

- This course will help students understand basic principles of information security.
- It also equips students with sufficient knowledge on digital signature and email security and fundamentals of web security

Course Outcomes

CO1: Understand information security models and analyze authentication mechanisms for challenge response scenarios.
CO2: Understand e-mail architecture and standards for securing mail communication.
CO3: Understand Internet Security Protocol and explore common solutions for security issues
CO4: Apply Web security protocols for E-Commerce applications

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2									3	2
CO2	2			2									3	2
CO 3	2			2									3	2
CO4	2	3	1	2									3	2

Syllabus

Unit 1
Digital Signature and Authentication Schemes
Digital signature- Hash functions, properties of hash functions, digital Signature Schemes and their Variants, digital Signature Standards. Authentication – Overview, Requirements Protocols, Applications, Kerberos, X.509 Directory Services.

Unit 2
E-mail and IP Security
Email Architecture, PGP, Operational Descriptions, Key management, Trust Model, S/MIME. IP Security – Overview, Architecture, ESP, AH Protocols, IPSec Modes, Security association, Key management.

Unit 3
Web Security
Requirements- Secure Sockets Layer- Objectives-Layers -SSL secure communication-Protocols - Transport Level Security. Secure Electronic Transaction- Entities DS Verification-SET processing.

Textbook(s)
Stallings W. "Cryptography and network security: principles and practice". Upper Saddle River: Pearson; 2018.
Stallings W. and Brown L. "Computer Security: Principles and Practice", Pearson; 2019.

Reference(s)
Forouzan BA. "Cryptography & network security". McGraw-Hill, Inc.; 2007 Feb 28.
Padmanabhan TR, Shyamala C K, and Harini N. "Cryptography and Security", First Edition, Wiley India Publications; 2011.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE333	SECURE CODING	L-T-P-C: 3-0-0-3

Course Objectives

The objective of this course is to provide students with a foundational understanding of secure coding practices and principles, and to equip them with the knowledge and skills necessary to develop and implement secure software applications. Through a combination of lectures, discussions, and hands-on exercises, students will gain an understanding of common software vulnerabilities and their impact and will learn how to apply secure coding principles and best practices to prevent security breaches. Students will also learn how to develop and implement effective input validation and data sanitization techniques, secure authentication and authorization mechanisms, secure session management techniques, and secure error handling and logging mechanisms. Finally, students will learn about secure coding frameworks and tools, and will be able to evaluate and apply secure coding guidelines and frameworks to ensure the security of their software applications.

Course Outcomes

CO1: Identify and prevent common software vulnerabilities through the application of secure coding principles and best practices.
CO2: Apply input validation and data sanitization techniques to protect against injection attacks such as SQL injection and XSS.
CO3: Employ secure authentication and authorization mechanisms, including secure password management and multi-factor authentication for web applications.
CO4: Apply secure session management techniques to prevent session hijacking and fixation attacks.
CO5: Analyze and Apply secure coding guidelines and frameworks to ensure the security of software applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1							3	3	2
CO2	3	2	3	2	2								3	3
CO 3	3	2	3	2	2								3	3
CO4	3	2	3	2	2								3	3
CO5	2	3	2	2	1							3	3	2

Syllabus

Unit 1
Introduction to Secure Coding Practices - Importance of secure coding in software development **-** Common software vulnerabilities and their impact, Secure coding principles and best practices, Overview of secure coding frameworks and guidelines. **Input Validation and Data Sanitization -** Importance of input validation in preventing injection attacks -Techniques for input validation and data sanitization - Handling user-controlled input securely - Protecting against SQL injection, XSS, and other injection attacks.

Unit 2
Authentication and Authorization - Secure authentication principles and mechanisms **-** Implementing secure password management **-** Multi-factor authentication techniques **-** Role-based access control and authorization. **Session Management -** Importance of secure session management **-** Techniques for secure session handling **-** Preventing session hijacking and fixation attacks **-** Implementing session timeouts and secure logout mechanisms.

Unit 3
Error Handling and Logging - Importance of error handling and logging in secure coding **-** Secure error message handling **-** Implementing effective logging and auditing mechanisms. **Secure Coding Frameworks and Tools -** Overview of secure coding frameworks and libraries **-** Utilizing secure coding tools and static code analysis **-** Secure coding practices for different programming languages **-** Secure software development lifecycle (SSDLC).

Textbook(s)
Dafydd Stuttard and Marcus Pinto, "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws," Wiley, 2nd edition, 2011.
Andrew Hoffman, "Web Application Security: Exploitation and Countermeasures for Modern Web Applications", O'Rielly, 2020.
Michael Howard, David LeBlanc. "Writing Secure Code", Microsoft Press, Second Edition; 2003.

Reference(s)
Mead NR, Allen JH, Barnum S, Ellison RJ, McGraw GR. "Software security engineering: a guide for project managers". Addison-Wesley Professional; 2004 Apr 21.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE334	CYBER FORENSICS AND MALWARE	L-T-P-C: 3-0-0-3

Course Objectives

- Provide learners with a comprehensive understanding of cyber forensics principles and techniques, enabling them to effectively identify, preserve, analyze, and report on digital evidence in various cybercrime investigations.
- Equip learners with the knowledge and skills to analyze and reverse-engineer malware using various analysis techniques, fostering an understanding of malware types, attack vectors, and behavior.
- Develop learners' proficiency in incident response and investigation, emphasizing the importance of following a structured process, maintaining a clear chain of custody for digital evidence, and applying cybersecurity best practices.

Course Outcomes

CO1: Understand the fundamentals of cyber forensics, including digital evidence, cyber forensic process, legal and ethical considerations.
CO2: Develop proficiency in various digital forensics techniques to effectively analyze and investigate cyber incidents.
CO3: Gain knowledge of malware types, behavior, and functionality, and learn how to identify, analyze, and reverse-engineer malicious software using static and dynamic analysis techniques.
CO4: Acquire the skills to properly respond to and investigate and mitigate cybersecurity threats and incidents.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1							1	2	2
CO2	3	3	2	3	3							2	3	3
CO 3	3	3	2	2	3							3	3	3
CO4	3	3	3	3	3							3	3	3

Syllabus

Unit 1
Introduction to Cyber Forensics - Basics of Cyber Forensics - Digital evidence and its types - Legal and ethical considerations. **Cyber Forensic Process** – Identification - Preservation – Collection – amination – Analysis – Reporting. **Digital Forensics Techniques -** Disk Forensics - File System Forensics - Network Forensics - Memory Forensics - Mobile Forensics - Cloud Forensics. **Incident Response and Investigation -** Incident response process - Incident response team - Chain of custody - Incident documentation.

Unit 2
Introduction to Malware - Malware types (viruses, worms, Trojans, ransomware, etc.) - Malware attack vectors c. Malware behavior and functionality. Malware Analysis Techniques - Static Analysis - File signatures, Hash analysis, Strings analysis, Disassembly - Dynamic Analysis – Sandboxing, Debugging, Network analysis, System and registry monitoring. **Reverse Engineering -** Assembly language basics - Disassemblers and debuggers - Control flow analysis - De-obfuscation techniques.

Unit 3
Anti-Malware Techniques - Antivirus software - Host-based Intrusion Detection and Prevention Systems (HIDS/HIPS) - Firewalls - Application control and whitelisting - Security patches and updates. **Cybersecurity Best Practices -** Security awareness and training - Defense in depth - Network segmentation - Data encryption - Strong authentication mechanisms - Regular security assessments and audits.

Textbook(s)
Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials," Addison-Wesley Professional, 1st edition, 2010.
Brian Carrier, "File System Forensic Analysis," Addison-Wesley Professional, 1st edition, 2005.

Sherri Davidoff and Jonathan Ham, "Network Forensics: Tracking Hackers through Cyberspace," Prentice Hall, 1st edition, 2012.

Reference(s)

Michael Sikorski and Andrew Honig, "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software," No Starch Press, 1st edition, 2012.
Michael Hale Ligh, Andrew Case, Jamie Levy, and Aaron Walters, "The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory," Wiley, 1st edition, 2014.
Eldad Eilam, "Reversing: Secrets of Reverse Engineering," Wiley, 1st edition, 2005.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE335	BLOCK CHAIN AND ITS APPLICATIONS	L-T-P-C: 3-0-0-3

Course Objectives

- This course examines the foundations of Blockchain technology from multiple perspectives.
- It is designed to provide students with an understanding of key concepts and developments around blockchain and its applications.

Course Outcomes

CO1: Understand the concepts of cryptocurrency, blockchain, and distributed ledger technologies.
CO2: Analyze the application and impact of blockchain technology in the financial industry and other industries.
CO3: Evaluate security issues relating to blockchain.
CO4: Design and analyse the impact of blockchain technology.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1										3	2
CO2	3	3	3										3	2
CO 3	3	3	3	3	2			2					3	2
CO4	3	3	3	2	3			2					3	2

Syllabus

Unit 1

Foundations of Blockchain

History of Blockchain,Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, Types of Blockchain, Consensus, Decentralization using Blockchain.

Unit 2

Blockchain applications

Blockchains for Trade Finance,Blockchains for Supply Chain Financing, Blockchain for Health Insurance Trusted Data Transfer with blockchain,Risks and Limitations of Blockchain

Unit 3

Blockchain deployment

Mining and forking - Upgrading the network - Related BIPs - Segregated Witness (SegWit). Blockchain architectures: Abstract Architecture - Ways to dive deeper - Introduction to major blockchain platforms, smart contracts.

TextBook(s)

Mohsen Attaran and Angappa Gunasekaran,"Applications of Blockchain Technology in Business Challenges and Opportunities",Springer International Publishing, Year: 2019
Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.

Reference(s)

Mougayar W. The business blockchain: promise, practice, and application of the next Internet technology. John Wiley & Sons; 2016 May 9.
Narayanan A, Bonneau J, Felten E, Miller A, Goldfeder S. Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press; 2016 Jul 19.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE336	SECURE NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives

- Equip students with a comprehensive understanding of fundamental cybersecurity concepts and network security principles, enabling them to design, implement, and manage secure network infrastructures.
- Develop students' proficiency in identifying and mitigating common web application vulnerabilities and threats.
- Foster students' ability to effectively monitor, analyze, and manage security events and incidents to maintain a secure environment.

Course Outcomes

CO1: Understand the key concepts and principles of network security, including the common network security. threats and vulnerabilities and be able to analyze and evaluate security risks in various contexts.
CO2: Apply skills in network architecture and design appropriate security measures.
CO3: Apply secure protocols and network security mechanisms to protect against attacks and ensure data confidentiality, integrity, and availability.
CO4: Understand the principles and applications of network monitoring tools and techniques, to effectively manage security risks and respond to security incidents in organizations.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2									3	3
CO2	3	3	3	2									3	3
CO 3	3	3	2	2	3								3	3
CO4	2	2	2	2				3					3	3

Syllabus

Unit 1
Introduction to Network Security - Basic concepts and terminologies - Importance of network security -Common network security threats and vulnerabilities. Network Architecture and Design. Secure network topologies and architectures - Defense-in-depth principles - Secure network segmentation and zoning - Access Control and Authentication.

Unit 2
Secure protocols (e.g., SSL/TLS, IPsec), Network-level attacks (e.g., DoS, DDoS), Intrusion detection and prevention systems (IDS/IPS), Network Perimeter Security. Firewalls and their configurations - Intrusion detection and prevention at the perimeter - Virtual Private Networks (VPNs) and secure remote access - Wireless Network Security.

Unit 3
Network monitoring tools and techniques - Vulnerability assessments and penetration testing - Incident detection, analysis, and response -Incident handling and post-incident procedures - Network Security Auditing and Testing.

Textbook(s)
J. Michael Stewart, Denise Kinsey, "Network Security, Firewalls, and VPNs", Jones & Bartlett Learning, LLC, 2020.
Sanders C, Smith J. "Applied network security monitoring: collection, detection, and analysis". Elsevier; 2013 Nov 26.

Reference(s)
William Stallings, "Network Security Essentials: Applications and Standards," Pearson, 6th edition, 2016.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignment, and Reports

* CAL – Can be Lab Assessments, Projects, and Reports

**End Semester can be theory examination/ lab-based examination/ project presentation

Electives in Computer Networks

23CSE341	WIRELESS SENSOR NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

- This course introduces the features of wireless sensor networks and their architecture.
- The protocols of MAC and network layer are discussed in detail.
- The course emphasizes localization and positioning schemes for real-time applications.

Course Outcomes

CO1: Understand the basic features of wireless sensor networks.
CO2: Understand and apply the features of different wireless sensor architectures for real-world scenarios.
CO3: Understand and apply the protocols of MAC and network layer for real-world wireless sensor networks.
CO4: Understand and apply localization and positioning schemes.
CO5: Analyze the design of wireless sensor networks for real-time applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	3	3	3	2	2	2	2	2	2	2		3	2
CO3	3	3	3	3	3	2	2	2	2	2	2		3	2
CO4	3	2	3	2	2	2	2	2	2	2	2		3	2
CO5	3	3	3	3	3	2	2	2	2	2	2		3	2

Syllabus

Unit 1
Overview of WSN: Introduction, Applications, Unique Constraints and challenges. Platforms for WSN: Sensor Node Hardwares (Introduction): Mica2, TelosB, Cricket, i-Mote2, TMote, BTnode, Wasp mote, Comparisons of these based on the specifications. Sensor Node Software's (Introduction): TinyOS and Contiki. Programming Tools: C, nesC. Single node architecture – Energy consumption of sensor nodes.

Unit 2
Network Architecture – Sensor network scenario-Design principles of WSN-Physical layer and transceiver design considerations in WSNs. MAC Protocols: Fundamentals of MAC protocols, Low Duty cycle Protocols and wake up concepts: SMAC, STEM, Contention Based Protocols: CSMA, PAMAS, Scheduling based Protocols: LEACH, SMACS, TRAMA.

Unit 3
Routing: Gossiping and agent –based unicast forwarding – Energy efficient unicast – Broadcast and multicast – geographic routing - Localization and Positioning: GPS based localization; Event Driven Localization- Overview of data aggregation - Wireless Sensor Network for Specific use case.

Textbook(s)
Karl H, Willig A. "Protocols and architectures for Wireless Sensor Networks". John Wiley & Sons; 2005.

Reference(s)
Ibrahiem M. M. El Emary S. Ramakrishnan, "Wireless Sensor Networks From Theory to Applications", CRC press, 2013.
Dargie W, Poellabauer C. "Fundamentals of Wireless Sensor Networks: theory and practice". John Wiley & Sons; 2010 Nov 5.
Zhao F, Guibas LJ, Guibas L. "Wireless Sensor Networks: an information processing approach". Morgan Kaufmann; 2004 Jul 20.
Anna Hac. "Wireless Sensor Networks Designs", John Wiley and Sons; 2004.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	20	
*Continuous Assessment Lab (CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE342	ADVANCED COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

- This course focuses on advanced networking concepts for next generation network architecture and design.
- It covers SDN and virtualization for designing next generation networks.

Course Outcomes

CO1: Understand advanced concepts and next generation networks
CO2: Analyze TCP/IP variants, network algorithms, protocols and their functionalities
CO3: Comprehend features of SDN and its application to next generation systems
CO4: Understand the functionalities of NFV and their roles in 5G

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2		2	2						3	2
CO2	3	3	2	2	3			2					3	2
CO3	2	2	2		3	2	2	2					3	2
CO4	3	3	2	2	3	2	2	2					3	2

Syllabus

Unit 1

Overview of data communication model - Internet Multicasting, NAT, VPN - Routing Algorithms - BGP, RIP, OSPF – Differentiated and Integrated Services - SONET, ATM – MPLS -Next generation Internet architectures, Green Communication Networks, and Data Center Networking.

Unit 2

Analysis of Network congestion Mechanism, Routing algorithms, ARQ protocols Multimedia Networking; Sliding Window protocol implementation, performance study of various TCP/IP variants.

Cellular and Ad Hoc wireless networks, Applications of ad hoc wireless networks. Issues in ad hoc wireless networks-medium access scheme, routing, transport layer protocols, security and energy management.

Unit 3

Software Defined Network -Comparison between SDN and traditional networks -SDN controller, Switch design, SDN Controller-Switch Protocols, Open Flow Protocol, Control Overhead & Handoff algorithms. Network Function Virtualization -NFV Architecture, Use cases, NFV Orchestration and NFV for 5G.

Textbook(s)

Tanenbaum AS, Wetherall D J. "Computer Networks". Fifth edition, Pearson Education, Inc. 2011.

Reference(s)

Stallings W. "Data and Computer Communications". Pearson Education India; 2006.
Douglas E Comer. "Internet Working with TCP/IP Volume -1", Sixth Edition, Addison-Wesley Professional;2013.
Goransson P, Black C, Culver T. "Software Defined Networks: A Comprehensive Approach". Morgan Kaufmann; 2014.
Chayapathi R, Hassan SF, Shah P. "Network Functions Virtualization (NFV) with a Touch of SDN: Netw Fun Vir (NFV ePub_1". Addison-Wesley Professional; 2016 Nov 14.
Marschke D, Doyle J, Moyer P. "Software Defined Networking (SDN): Anatomy of OpenFlow", Volume 1. 2015.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials

* CAL – Can be Lab Assessments, Projects, and Reports

**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE343	WIRELESS AND MOBILE NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

This course provides an overview on the dynamics of wireless environment and means of communication across heterogeneous networks.

Course Outcomes

CO1: Understand the principles of mobile and wireless systems.
CO2: Understand multiple access schemes of wireless and mobile networks.
CO3: Analyze the working of various transport layer protocols in heterogeneous networks.
CO4: Analyze routing aspects of mobile hosts in wireless systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2		2	2	2					3	2
CO2	3	2		2			2	2		2			3	2
CO3	3	2	3	2	3								3	2
CO4	3	2	3	2	3	2	2			2			3	2
CO5	3	3	3	3	2								3	2

Syllabus

Unit 1
Introduction to wireless communications: Evolution of mobile radio communications. Cellular telephone system, Modern wireless communication systems: 2G, 3G, 4G wireless system and standards, Bluetooth and wireless personal area networks. Basic wireless propagation mechanisms-Reflection, diffraction and scattering.

Unit 2
Digital Cellular Transmission, Spread Spectrum , Multiple Access techniques - frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), space division multiple access (SDMA), Diversity and multiplexing -Time diversity, frequency diversity and space diversity, Evolution of wireless LAN, IEEE802.11,physical layer, MAC sub-layer, CSMA/CA, Adhoc networks: Characteristics – performance issues.

Unit 3
Cellular Concept: Frequency reuse, channel assignment strategies, handoff strategies, improving coverage and capacity in cellular systems, routing in mobile hosts. Mobile IP – DHCP – Mobile transport layer – Indirect TCP – Snooping TCP – Transmission/time-out freezing – selective retransmission –Transaction oriented TCP.

Textbook(s)
Stallings W. "Wireless Communications & Networks". Pearson Education India; 2009.

Reference(s)
Jochen.S. "Mobile Communications", Pearson Education Limited;2004.
Lee W C Y. "Wireless and Cellular Communications", Third Edition, Tata McGraw Hill Publishing Company Limited; 2006.
Rappaport T.S. "Wireless Communication: Principles and Practice", Second Edition, Pearson Education;2009.
Pahlavan K, Krishnamurthy P. "Networking Fundamentals: Wide, Local and Personal Area Communications". John Wiley & Sons; 2006.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	20	
*Continuous Assessment Lab (CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE344	MODERN CELLULAR WIRELESS NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

Evolution of Wireless Technology to 5G and beyond is a course offered as an elective to B. Tech CSE students in Computer Science & Engineering. The course introduces the mobile wireless network generations with special emphasis on 5G to the students. The course also introduces a potential path to 6G and future IoT networks. The major course objectives are:

- Understand the timeline of mobile wireless networks from 1G to 5G.
- Understand the evolution of the 5G architecture towards 6G.
- Understand 5G key concepts, use cases, requirements.

Course Outcomes

CO1: Understand mobile network technologies and the advancements in different generations.
CO2: Understand 5G key concepts, use cases, requirements.
CO3: Apply the principles of body area networks for real time applications.
CO4: Understand the evolution of wireless networks beyond 5G.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO2	3	2	2	1	-	-	-	-	-	-	-	2	3	2
CO3	3	3	3	3	1	2	-	-	-	-	-	2	3	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Basics of wireless communication, Wireless transmission and reception process, Radio spectrum, Data rate, Cellular concept, Call set-up/release, Mobility management and handover schemes, Timeline of wireless technologies from 1G to 4G, Network evolution from 4G Evolved Packet Core to 5G, Architecture changes compared to 4G.

Unit 2
5G new radio (NR), Network Architecture for 5G NR, 5G NR spectrum, Enhanced Mobile Broadband (eMBB), massive Machine-Type Communications(m-MTC), Ultra Reliable Low Latency Communication (URLLC).

Unit 3
5G Radio Access Network (RAN), Traditional and virtualized RAN, Private network, Neutral Hosts, Massive IoT, Spectrum options, Towards 6G networks design and standardization.

Body Area Networks: Introduction to BAN, BAN Architecture, Technical Challenges - Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability,

Textbook(s)
Venkataraman, Hrishikesh, and Ramona Trestian. "5G Radio Access Networks: centralized RAN, cloud-RAN and virtualization of small cells", CRC Press, 2017.
Rodriguez, Jonathan. "Fundamentals of 5G mobile networks", John Wiley & Sons, 2015.

Reference(s)
Holma, Harri, Antti Toskala, and Jussi Reunanen. "LTE small cell optimization: 3GPP evolution to Release 13", John Wiley & Sons, 2016.
Latest white papers and tutorials on 5G and 6G.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	20	
*Continuous Assessment Lab (CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE345	SOFTWARE DEFINED NETWORKS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

The main objective of the course is to impart knowledge on the basic concepts related to Software Defined Networking, Network Function Virtualization, and Implementation of SDN. The focus then shifts to understating different SDN Controllers and security in SDN.

Course Outcomes

CO1: Understand the challenges and opportunities associated with adopting SDN compared to traditional approaches of networking.
CO2: Understand the underlying technologies that enable SDN, including OpenFlow, north and southbound APIs, controllers, and overlays.
CO3: Analyze the operations of SDN network consisting of switches and a centralized controller through simulation.
CO4: Comprehend the functionalities and applications of NFV.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	2	-	-	-	-	-	-	-	-
CO2	3	1	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	-	2	-	3	-	-	-	-	-	-	-	-	-
CO4	3	1	2	-	3	-	-	-	-	-	-	-	-	-

Syllabus

Unit 1
Evolution of Software Defined Networking (SDN), Modern data centre, Traditional switch architecture, How SDN works – Control and data planes- centralized and distributed. Network topologies and implementation in SDN, Open Flow Specification –Important APIs.

Unit 2
SDN Controllers - Open Daylight, RYU, Floodlight Controller, Quality of Service (QoS), Quality of Experience (QoE) – Network design to meet user needs, Data center orchestration, SDN solutions for the Data center networks.

Unit 3
Network Functions Virtualization (NFV) -Virtualization and data plane I/O, Security as a service using SDN and NFV. Implementation of SDN using Mininet.

Textbook(s)
Thomas D Nadeau and Ken Gray. "SDN: Software Defined Networks- An Authoritative Review of Network", Programmability Technologies Oreilly,2013

Reference(s)
William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Oreilly 2015.
OpenFlow Switch Specifications, Open Networking Foundations, Version 1.3 or later
Siamak Azodolmolky , "Software Defined Networking with OpenFlow", PACKT Publishers 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

Electives in Data Science

23CSE351	FOUNDATIONS OF DATA SCIENCE	L-T-P-C:3-0-0-3

Course Objectives

- To teach primary tools for exploration, visualizations and descriptive statistics, for prediction are machine learning and optimization, and for inference are statistical tests and models.
- To make students learn to ask appropriate questions about their data and correctly interpret the answers provided by inferential and computational tools.

Course Outcomes

CO1: Understand the statistical foundations of data science.
CO2: Apply pre-processing techniques over raw data to enable further analysis.
CO3: Conduct exploratory data analysis and create insightful visualizations to identify patterns.
CO4: Identify machine learning algorithms for regression/classification tasks and to get into insights.
CO5: Analyze the degree of certainty of predictions using statistical tests and models.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1												2	2
CO2	1	1		1	3								2	2
CO3	3	1	1	2	3								2	2
CO4	3	1	1	2	2			2					2	2
CO5	3	3	1	3	2								2	2

Syllabus
Unit 1
Introduction to Data Science, Causality and Experiments, **Data Preprocessing:** Data cleaning, Data reduction, Data transformation, Data discretization. **Exploratory Data Analysis in python:** Visualizing categorical data, numerical data, summary statistics of data, overlaid graphs. **Random Variables:** Random variables, Functions of Random variables Probability Distributions: Discrete and continuous distributions, **Sampling**: Sampling Concepts, The Central Limit Theorem and Applications. Sample Means and Sample Sizes.

Unit 2
Descriptive statistics: Central tendency, dispersion, variance, covariance, kurtosis, five-point summary, Distributions, Bayes Theorem, Error Probabilities; Permutation Testing, **Hypothesis and Inference:** P-Values, Hypothesis Testing, Assessing Models, Decisions and Uncertainty, Comparing Samples, Chisquared Test, A/B Testing.

Unit 3
Linear Regression: Building the regression model **-** Least square line, Predictions using regression models – Uncertainties in regression coefficients, checking assumptions and transforming data, web scrapping, **Introduction to Data Visualization Tools:** Tableau, PowerBI.

Textbook(s)
Ani Adhikari and John DeNero, David Wagner. "Computational and Inferential Thinking: The Foundations of Data Science",2nd Edition, e-book 2021. https://inferentialthinking.com/chapters/intro.html.

Reference(s)
William Navidi, "Statistics for Engineers and Scientists", Fifth Edition, McGraw Hill, 2020.

Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr. "Data Mining for Business Analytics: Concepts, Techniques and Applications in R", Wiley India, 2018.
Rachel Schutt & Cathy O'Neil, "Doing Data Science", O' Reilly, First Edition, 2013.
Joel Grus, "Data Science from Scratch", Second edition, O'Reilly Media, Inc. 2019.
Wes McKinney, "Python for Data Analysis", Wes McKinney, Third Edition, O'Reilly, 2022.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

* CAT - Can be Quizzes, Assignments, and Tutorials
* CAL – Can be Lab Assessments, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE352	BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- To provide in-depth knowledge about big data Technologies and tools used for big data.
- To facilitate students to learn to implement and work on tools to handle large volumes of data in parallel and distributed environments.
- To throw light on retrieval and analysis of unstructured data using NOSQL databases.
- To impart in-depth knowledge of Spark and Spark MLlib.

Course Outcomes

CO1: Understand fundamental concepts of Big Data and its technologies.
CO2: Apply concepts of MapReduce framework for optimization.
CO3: Analyze appropriate NoSQL database techniques for storing and processing large volumes of structured and unstructured data.
CO4: Apply data analytics solutions using Hadoop ecosystems and Spark.
CO5: Explore modern big data processing packages for Machine learning.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1							1			3	2
CO2	3	3	2	2	3	2	2	2	2	2			3	2
CO3	3	3	2	2	3	2	2	2	2	2			3	2
CO4	3	3	2	2	3	2	2	2	2	2			3	2
CO5	2			2	3		2	3	2	2			3	2

Syllabus

Unit 1
Hadoop ecosystem in Brief –Basic Paradigm and system architecture, MapRedand HDFS, Making a small Hadoop cluster – Iterative and non-Iterative batch processing, Data stores, HBASE, HIVE, PIG-New generation Big data using Functional

Programming in Scala: Basic Syntax-type inference and static types-function types and value types, closures.

Unit 2

Immutability and immutable types-generic type Parameters-Recursive arbitrary collections –ConsList -Iterative arbitrary collections-Arrays-Tail recursion-factorial example-functional abstractions with examples-square root, fixed point, sequence summations. Higher order functions-MapReduce Template-Pattern Matching syntax. Similar higher order (Cons) List operations on arbitrary Collections-filter, fold, partition, span. Basic entity classes and objects in Scala.

Unit 3

Apache Spark: -ResilientDistributed Datasets -Creating RDDs, Lineage and Fault tolerance, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization -Formatting and housing data from spark RDDs--Persistence. Setting up a standalone Spark cluster-: spark-shell, basic API, Modules-Core, Key/Value pairs and other RDD features, MLlib-examples for bi-class SVM and logistic regression.

Textbook(s)

Holden Karau, Andy Konwinski, Patrick Wendell and MateiZaharia, "Learning Spark: Lightning-Fast Big Data Analysis", 1st Edition,2015.

Reference(s)

Cay S. Horstmann, "Scala for the Impatient", 2nd Edition,2017.
Bill Chambers and MateiZaharia, "Spark: The Definitive Guide: Big Data Processing Made Simple", 1st Edition,2018.
Martin Odersky, Lex Spoon and Bill Venners, "Programming in Scala: A Comprehensive Step-by-Step Guide", 3rd Edition,2008.
Holden Karau and Rachel Warren, "High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark", 1st Edition,2017.
Tom White, "Hadoop: The Definitive Guide", 4th Edition, 2015.

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
*Continuous Assessment (Theory) (CAT)	10	
*Continuous Assessment (Lab) (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE353	DATA VISUALIZATION	L-T-P-C: 3-0-0-3

Course Objectives

- To provide knowledge on visualization design principles and deciding the type of visualization chart to choose for the given datasets.
- To teach on creating simple to advanced chart types using python modules and libraries.
- To help students explore, visualize and analyse various types of data sets such as geospatial and multimodal data.
- To help students work on visualization tools and enable them to understand the visual analytics such as dashboards and storytelling with a hands-on experience on tableau and R.

Course Outcomes

CO1: Understand the importance of Data Visualization and learn to create basic charts by applying visualization design principles

CO2: Learn to create advanced visualization charts and analysis.

CO3: Explore and analyse geospatial and multimodal data.

CO4: Learn to build interactive/animated and ethically correct dashboards, construct data stories, and communicate important trends/patterns in the data sets.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1								2	3	2
CO2	2	3		2								2	3	2
CO3	2	2		3								2	3	2
CO4	3	2		2				3				2	3	2

Syllabus

Unit 1
Introduction to Data Visualization – Principles – Storytelling with data - Data Visualization tools - Matplotlib - How to Display the plots - Plotting from a script - Adjusting the Plot: Line Colors and Styles - Axes Limits - Labelling Plots - Simple Scatter Plots - Visualizing Errors - Density and Contour Plots - Histograms, Binnings, and Density, Kernel density estimation – Legend - Customizing Colorbars - Choosing the colormap - Sequential colormaps - Divergent colormaps - Qualitative colormaps - Color limits and extensions - Manifold embedding of handwritten digit pixels - Multiple Subplots - Text and Annotation - Transforms and Text Position - Arrows and Annotation - Customizing Ticks – Stylesheets – ggplot - Three-Dimensional Plotting - Contour Plots - Wireframes and Surface Plots - Surface Triangulations

Unit 2
Geographic Data with Basemap - Map Projections - Cylindrical projections - Perspective projections - Conic projections - Drawing a Map Background - Plotting Data on Maps – Visualization with Seaborn - Pair plots - Factor plots - histogram as a special case of a factor plot - violin plot.
Unit 3
Tableau - Advanced visualizations with Tableau - Choropleth Maps - Waffle Charts – Dashboards – Creating Dashboards with Tableau and Plotly – Data visualization with R - Data Ethics and Visualization Ethics.

Textbook(s)
Jake VanderPlas, "Python Data Science Handbook - Essential Tools for Working with Data", O'Reilly, 2nd Edition, 2022.
Wes McKinney, "Python for Data Analysis", O'Reilly, 2nd Edition, 2023.
Tamara Munzner, "Visualization Analysis and Design", A K Peters Visualization Series, CRC Press, 2014.

Reference(s)
Scott Murray," Interactive Data Visualization for the Web", O'Reilly, 2013.
Alberto Cairo, "The Functional Art: An Introduction to Information Graphics and Visualization", New Riders, 2012.
Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization Guide for Business Professionals", Wiley, 2015.
Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", John Wiley & Sons, 2011.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	-
*Continuous Assessment (Theory) (CAT)	10	-
*Continuous Assessment (Lab) (CAL)	40	-
**End Semester	-	30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE354	**DATABASE MANAGEMENT SYSTEMS FOR DATA SCIENCE**	**L-T-P-C: 3-0-0-3**

Course Objectives

- To help students learn SQL for data preparation, data querying and analysing data stored in a database.
- To make students thoroughly understand data analysis in specific applications such as time series analysis, cohort analysis, text analysis, anomaly detection and experiment analysis.

Course Outcomes

CO1: Understand how to use SQL query for data preparation, data cleaning, and profiling the data stored in databases.

CO2: Apply SQL features to output data for business Intelligence tool for reports and dashboards creation.

CO3: Conduct Time series Data Analysis and cohort analysis to calculate rolling time windows, identify seasonal patterns, repeat behaviour, and cumulative actions.

CO4: Carry out text analysis using SQL functions.

CO5: Analyse data using experiment analysis techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3				3				3	2
CO2	1	3	3	3	3				3	2			3	2
CO3	2	3	2	3				2	2	2	2		3	2
CO4	1	1	1	2									3	2
CO5	1	1												

Syllabus

Unit 1
Overview of Database and Database management systems – SQL – SQL for data science –Analysis with SQL – Data Analysis Workflow – Database types – Preparing data for analysis – Types of data – SQL query structure – Profiling – Distributions – Data quality – Deduplication with GROUP BY and DISTINCT - Data cleaning - Dealing with Nulls: coalesce, nullif, nvl Functions - Missing Data - Preparing: Shaping Data - BI, Visualization, Statistics, ML - Pivoting with CASE Statements - Unpivoting with UNION Statements - pivot and unpivot Functions

Unit 2
Time Series Analysis - Date, Datetime, and Time Manipulations - Trending the Data - Cohorts – Cohort Analysis – Analysis Framework - Rolling Time Windows – Sparse Data - Analyzing with Seasonality - Retention - SQL for a Basic Retention Curve - Adjusting Time Series to Increase Retention Accuracy - Cohorts Derived from the Time Series - Defining the Cohort from a Separate Table - Dealing with Sparse Cohorts - Defining Cohorts from Dates Other Than the First Date - Related Cohort Analyses - Survivorship - Returnship, or Repeat Purchase Behavior - Cumulative Calculations - Cross-Section Analysis, Through a Cohort Lens

Unit 3
Text Analysis with SQL - What Is Text Analysis - Why SQL Is a Good Choice for Text Analysis - When SQL Is Not a Good Choice - The UFO Sightings Data Set - Text Characteristics - Text Parsing - Text Transformations - Finding Elements Within Larger Blocks of Text - Wildcard Matches: LIKE, ILIKE - Exact Matches: IN, NOT IN - Regular Expressions - Constructing and Reshaping Text - Concatenation - Reshaping Text - Database and cloud – Built-in functions – python support for accessing databases.

SQL for anomaly detection - Experiment Analysis with SQL - Correlation Is Not Causation - Experiments with Binary Outcomes: The Chi-Squared Test - Experiments with Continuous Outcomes: The t-Test – Challenges - Variant Assignment – Outliers - Time Boxing - Pre-/Post-Analysis - Natural Experiment Analysis

Textbook(s)
Cathy Tanimura, "SQL for Data Analysis: Advanced Techniques for Transforming Data into Insights", O'Reilly Media, 2021.

Richard Machina, "SQL Programming For Beginners: The Guide With Step by Step Processes on Data Analysis", 2020.

Reference(s)

Anthony DeBarros, "Practical SQL, A Beginner's Guide to Storytelling with Data", 2nd Edition, No starch press, 2022.
Upom Malik, Matt Goldwasser, Benjamin Johnston, "SQL for Data Analytics: Perform fast and efficient data analysis with the power of SQL", Packt Publishing, Year: 2019.
Silberschatz. A., Korth, H. F. and Sudharshan, S., "Database System Concepts", 6th Edition, TMH, 2010.
Elmasri, R. and Navathe, S. B., "Fundamentals of Database Systems", 5th Edition, Addison Wesley, 2006.
Date, C. J. , "An Introduction to Database Systems", 8th Edition, Addison Wesley, 2003.
Ramakrishnan, R. and Gehrke, J., "Database Management Systems", 3rd Edition, McGrawHill, 2003.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	-
*Continuous Assessment (Theory) (CAT)	10	-
*Continuous Assessment (Lab) (CAL)	40	-
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE355	MINING OF MASSIVE DATASETS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Machine Learning

Course Objectives

- To understand various scalable machine learning algorithms to solve big data problems.
- To understand the SPARK architecture.
- To implement Machine Learning algorithms using PySpark.

Course Outcomes

CO1: Understand how Machine learning algorithms are made scalable to solve big data problems.
CO2: Implement scalable Machine Learning algorithms using PySpark.
CO3: Apply and compare different strategies for big data analytics using various machine learning algorithms.
CO4: Understand Streaming algorithms to analyze voluminous and high dimensional data.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3				2				3	2
CO2	3	3	3	3	3				3	2	3		3	2
CO3	2	3	2	3	2				2	2	2		3	2
CO4	1	1	1	2	2				2	2	2		3	2

Syllabus

Unit 1

Introduction to Spark: Spark Architecture, Spark Jobs and APIs. Resilient Distributed Datasets- Creating RDDs, Transformation, Actions. Dataframes- Python to RDD communications, Creating Dataframes, Dataframe queries. MLlib -Loading and Transforming the data. Implementation of Machine Learning algorithms such as Classification and Clustering using the MLlib.

Unit 2

Approaches to Modelling- Importance of Words in Documents - Hash Functions- Indexes - Secondary Storage -The Base of Natural Logarithms - Power Laws - Map Reduce. Finding similar items: Shingling – LSH - Distance Measures. Mining Data Streams: Stream data model - Sampling data - Filtering streams. Link Analysis: Page Rank, Link Spam.

Unit 3

Frequent Item Sets: Market Basket Analysis, A-Priori Algorithm - PCY Algorithm. Recommender Systems, Dimensionality Reduction -SVD, Big data Clustering: Clustering in Non-Euclidean Spaces, BFR, CURE. Structured Streaming: Spark Streaming, Application dataflow.

Textbook(s)

AnandRajaRaman, Jure Leskovec and J.D. Ullman, "Mining of Massive Data sets", e-book, Publisher, 2014.

Reference(s)

Viktor Mayer-Schönberger, Kenneth Cukier, "Big Data: A Revolution That Will Transform How We Live, Work, and Think", Houghton Mifflin Harcourt, 2013.

Bill Chambers, Matei Zaharia, "Spark: The Definitive Guide", O'Reilly Media Inc,2018, ISBN: 9781491912218. Kevin P. Murphey, "Machine Learning, a Probabilistic Perspective", The MIT Press Cambridge, Massachusetts, 2012.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment Theory (CAT)	10	
*Continuous Assessment Lab (CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports

*CAL – Can be Lab Assessments, Project, and Report

**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE356	SOCIAL NETWORK ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the basic concept and structure of social networks and its implications.
- To focus on analysing massive networks, which provide many computational, algorithmic, and modelling challenges.
- To enable students to practically analyse large-scale network data and how to reason about it through models for network structure and evolution.

Course Outcomes

CO1: Understand the concept and structure of social networks and its implications.
CO2: Understand the measures and metrics used in social networks and its computation.
CO3: Explore social media data and analyze it.
CO4: Perform analysis of social network data using machine learning techniques.
CO5: Community identification and link prediction in social networks based on graph processing techniques in Python.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	2	-	-	-	-	-	-	3	2
CO2	3	2	1	-	-	-	-	-	-	-	-	-	3	2
CO3	2	1	2	2	-	-	-	-	-	-	-	-	3	2
CO4	2	3	3	3	3	2	2	2	-	2	-	-	3	2
CO5	3	2	2	2	3	-	-	2	2	2	-	-	3	2

Syllabus

Unit 1
Networks and Society**:** Introduction of SNA; Three Levels of Social Network Analysis; Graph Visualisation Tools;Network Measures: Network Basics, Node Centrality, Assortativity, Transitivity and Reciprocity, Similarity, Degeneracy. Network Growth Models: Properties of Real-World Networks; Random Network Model; Ring Lattice Network Model; Watts–Strogatz Model; Preferential Attachment Model; Price's Model; Local-world Network Growth Model; Network Model with Accelerating Growth; Aging in Preferential Attachment - Link Analysis: Applications of Link Analysis; Signed Networks; Strong and Weak Ties; Link Analysis Algorithms; PageRank; Personalised PageRank; DivRank; SimRank; PathSIM

Unit 2
Community Structure in Networks: Applications of Community Detection, Types of Communities, Community Detection Methods; Disjoint Community Detection; Overlapping Community Detection; Local Community Detection; Community Detection vs Community Search; Evaluation of Community Detection Methods - Link Prediction: Applications of Link Prediction, Temporal Changes in a Network; Problem Definition; Evaluating Link Prediction Methods; Heuristic Models; Probabilistic Models; Supervised Random Walk; Information-theoretic Model; Latest Trends in Link Prediction - Cascade Behaviours and Network Effects: Preliminaries and Important Terminologies; Cascade Models; Case Study – The "Indignados" Movement; Probabilistic Cascades; Epidemic Models; Independent Cascade Models; Cascade Prediction

Unit 3
Anomaly Detection in Networks: Outliers versus Network-based Anomalies; Challenges; Anomaly Detection in Static Networks; Anomaly Detection in Dynamic Networks - Graph Representation Learning: Machine Learning Pipelines; Intuition behind Representation Learning; Benefits of Representation Learning; Criterion for Graph Representation Learning; Graph Representation Learning Pipeline; Representation Learning Methods - Applications and Case Studies: Malicious Activities on OSNs; Sockpuppets in OSNs; Collusion on Online Social Networks; Modelling the Spread of a pandemic

Textbook(s)
Tanmoy Chakraborty," Social Network Analysis", Wiley, 2021.

Reference(s)

Matthew A. Russell, Mikhail Klassen, “Mining the Social Web”, 3rd Edition, O’Reilly, 2019.
Albert-Lazzlo Barabasi, “Network Science”, Cambridge University Press, 2016.
Stanley Wasserman, Katherine Faust, “Social Network Analysis: Methods and Applications”, Cambridge University Press, 2012.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	-
*Continuous Assessment (Theory) (CAT)	10	-
*Continuous Assessment (Lab) (CAL)	40	-
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE357	TIME SERIES ANALYSIS AND FORECASTING	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce the principles and methods of forecasting.
- To introduce various components of time series and time series models which cater to the real-world applications.
- To help students explore and use the various criteria used for performance evaluation.
- To address both the aspects of descriptive and predictive analytics.

Course Outcomes

CO1: Understand the principles and process of forecasting.
CO2: Apply and analyze Univariate ARIMA methods for real world problems.
CO3: Apply and analyze Smoothing methods for real world problems.
CO4: Apply various criteria for evaluating model quality.
CO5: Apply and analyze multivariate methods for real world problems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	1	2	3	-	-	-	-	-	-	-	3	2
CO3	2	1	-	1	3	-	-	-	-	-	-	-	3	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	2	1	2	3	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1

Planning and Forecasting – Forecasting process – Time Series patterns – Statistical fundamentals for forecasting –Descriptive statistics - Measuring errors – Correlation and Covariance – Autocorrelations – Linear Regression analysis – Dependent and independent variables - Method of least square deviations – Durbin-Watson Statistic – Univariate methods

Unit 2

Univariate ARIMA methods – ARIMA model identification – Time series examples – Integrated Stochastic process– Backward shift operator - Autoregressive processes – Yule-Walker equations - ARIMA prediction intervals -Multiple Regression models – Serial correlation – Elasticities and Logarithmic relationships - Heteroscedasticity –Intervention functions – Nonstationary series.

Unit 3

Smoothing methods – Decomposition methods – Trend-Seasonal and Holt-Winters smoothing - SARIMA processes - SARIMA fitting - Akaike Information Criterion- Schwarz Bayesian Information Criterion and Model Quality.

Textbook(s)

Stephen A. DeLurgio, "Forecasting Principles and Applications", McGraw Hill International Editions 2 Revised ed Edition - 1 July 1998. ISBN-13: 978-0071159982 ISBN-10: 0071159983.
Galit Shmueli, Kenneth C. Lichtendahl Jr., Axelrod.," Practical Time Series Forecasting with R: A Hands-On Guide", Second Edition, Schnall Publishers; 2016
Rob J Hyndman and George Athanasopoulos, "Forecasting: Principles and Practice", Third Edition, Otexts; 2018.

Reference(s)

Ruet S. Tsay, "Analysis of Financial Time Series", 3rd Edition, Wiley, New Jersy, 2015.
Walter Enders, "Applied Econometrics", 3rd Edition, Wiley, New Jersy, 2014.
Terence C. Mills, "The Foundations of Modern Time Series Analysis", Palgrave Macmillan; 2011.
Kerry Patterson, "An Introduction to Applied Econometrics - A Time Series Approach", Macmillan Press Limited;2000.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	-
*Continuous Assessment (Theory) (CAT)	10	-
*Continuous Assessment (Lab) (CAL)	40	-
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

Electives in Cyber Physical Systems

23CSE361	REAL TIME OPERATING SYSTEMS FOR CYBER PHYSICAL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Operating Systems, 23CSEXXX Embedded Systems

Course Objectives

- Understand the characteristics of real-time systems in the context of cyber-physical systems (CPS) and differentiate between general-purpose operating systems and real-time operating systems (RTOS) in CPS.
- Explore the design considerations, scheduling algorithms, task synchronization, communication mechanisms, memory management, and protection in RTOS for CPS, as well as real-time file systems and device drivers.
- Develop skills in performance evaluation, analysis, and testing of RTOS in CPS, including measuring key performance metrics, studying performance analysis techniques, and understanding real-time debugging and testing methods. Gain awareness of challenges and open research issues in the field of RTOS for CPS.

Course Outcomes

CO1: To understand the concepts of real-time operating systems and their applications in Cyber Physical Systems.
CO2: To be able to design, develop and analyze real-time operating systems for Cyber Physical Systems.
CO3: To understand the concepts of task scheduling, resource management, and inter-process communication in real-time operating systems.
CO4: To be able to evaluate and analyze the performance of real-time operating systems for Cyber Physical Systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	0	-	-	-	-	1	1	-	-	-	2	2
CO2	3	3	2	-	-	-	-	1	1	-	-	-	2	2
CO3	3	3	2	-	-	-	-	1	1	-	-	-	2	2
CO4	3	3	1	-	-	-	-	1	1	-	-	-	2	2

Syllabus

Unit 1
Definition of real-time systems and their characteristics in the context of cyber-physical systems. Comparison between general-purpose operating systems and RTOS. Classification of RTOS based on scheduling algorithm and kernel architecture. Design considerations for RTOS in CPS. Case studies of RTOS in CPS, including examples from robotics, autonomous vehicles, and industrial control systems.

Unit 2
Overview of task scheduling and resource management in RTOS for CPS. Priority-based scheduling algorithms: Rate Monotonic Scheduling (RMS), Earliest Deadline First (EDF), and others for CPS. Task synchronization and communication mechanisms in RTOS for CPS. Memory management and memory protection in RTOS for CPS. Real-time file systems and device drivers.

Unit 3
Metrics for performance evaluation of RTOS: response time, deadline miss ratio, throughput, and others.
Performance analysis techniques for RTOS. Case studies of performance analysis and evaluation of RTOS in cyber-physical systems. Real-time debugging and testing of RTOS. Challenges and open research issues in RTOS.

Textbook(s)

K.C. Wang, "Embedded and Real-Time Operating Systems", Springer, 2017.

Reference(s)
Hermann Kopetz, “Real-Time Systems: Design Principles for Distributed Embedded Applications”, Springer, 2022.
Jean J Labrosse, “uC/OS-III: The Real-Time Kernel”, Micrium Press, 2010.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment (*CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE362	EDGE COMPUTING	L-T-P-C: 3-0-0-3

Course Objectives

- This course aims to teach students about edge computing for cyber-physical systems, including its design, implementation, and evaluation.
- Students will learn about various applications of edge computing in cyber-physical systems, enabling them to gain practical knowledge in the field.
- Upon completion of this course, students will have a solid understanding of edge computing and its role in the emerging field of cyber-physical systems.
- Understand the characteristics of real-time systems in the context of cyber-physical systems (CPS) and differentiate between general-purpose operating systems and real-time operating systems (RTOS) in CPS.
- Explore the design considerations, scheduling algorithms, task synchronization, communication mechanisms, memory management, and protection in RTOS for CPS, as well as real-time file systems and device drivers.
- Develop skills in performance evaluation, analysis, and testing of RTOS in CPS, including measuring key performance metrics, studying performance analysis techniques, and understanding real-time debugging and testing methods. Gain awareness of challenges and open research issues in the field of RTOS for CPS.

Course Outcomes

CO1: Understand the fundamental concepts of edge computing and its significance in the context of distributed systems.
CO2: Ability to design edge computing solutions, including architectures, models, and platforms.
CO3: Develop knowledge of resource management techniques in edge computing, including task scheduling algorithms, resource allocation algorithms, and load balancing algorithms.
CO4: Apply performance analysis and optimization techniques to evaluate the effectiveness and efficiency of edge computing solutions.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	-	-	-	-	-	1	-	-	-	2	2
CO3	3	3	2	-	-	-	-	-	1	-	-	-	2	2
CO4	3	3	1	-	-	-	-	-	1	-	-	-	2	2

Syllabus

Unit 1
Overview of edge computing and its significance in distributed systems. Edge computing architectures, models, and platforms. Comparison of edge computing with cloud computing and fog computing. Case studies of edge computing applications

Unit 2
Resource management in edge computing and its challenges. Resource management techniques for edge computing, including task scheduling algorithms, resource allocation algorithms, and load balancing algorithms. Case studies and applications of resource management in edge computing, such as mobile edge computing, and autonomous vehicles.

Unit 3
Metrics for measuring performance in edge computing: latency, throughput, and energy efficiency. Case studies of performance analysis and optimization in edge computing, such as edge-based video streaming, smart transportation systems, and healthcare IoT devices. Emerging trends in edge computing: edge intelligence, serverless computing, edge security, and hybrid cloud and edge architectures.

Textbook(s)
K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani and M. Niranjanamurthy,"Edge Computing Fundamentals, Advances and Applications", CRC Press, 2022.

Reference(s)
Xin Sun and Amin Vahdat, "Edge Computing: A Primer", CRC Press, 2019.
Daniel Situnayake, Jenny Plunkett, "AI at the Edge", O'Reilly Media, Inc, 2023.
Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing Principles and Paradigms", John Wiley & Sons, Inc.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Projects, and Reports
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE363	CLOUD COMPUTING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Networks

Course Objectives

- This course helps students to acquire a solid understanding of cloud computing fundamentals, including service and deployment models, to make informed decisions when selecting and implementing cloud-based solutions for various projects and scenarios.
- Learn and apply modern cloud-native application development techniques, such as microservices, containerization, and container orchestration, to build scalable, resilient, and efficient applications that leverage the full potential of cloud environments.
- Develop practical skills in managing and monitoring cloud deployments, focusing on orchestration, automation, and resource management, enabling students to optimize and maintain cloud-based solutions for improved performance, cost-effectiveness, and overall operational efficiency.

Course Outcomes

CO1: Understanding of core cloud computing concepts, service models, and deployment models, along with the ability to identify the benefits and challenges associated with cloud computing.
CO2: Proficiency in utilizing cloud infrastructure and services with the ability to design and manage cloud resources effectively.
CO3: Ability to develop and deploy cloud applications by incorporating knowledge of compute, storage, and networking services.
CO4: Competence in cloud-native application development, including the design and implementation of microservices, containerization with Docker, and container orchestration.
CO5: Proficiency in managing and monitoring cloud environments, encompassing cloud orchestration, automation, and resource management techniques.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2	1	3								2	2
CO2	3	3	3	2	3				2				3	3
CO3	3	3	3	2	3				2				3	3
CO4	3	3	3	2	2				2				3	3
CO5	3	3	2	2	3				2				3	3

Syllabus

Unit-1
Introduction to Cloud Computing - Definition and evolution of cloud computing - Cloud computing service models: IaaS, PaaS, SaaS - Cloud deployment models: Public, Private, Hybrid, and Community Clouds - Benefits and challenges of cloud computing. Cloud Infrastructure and Services - Cloud computing architecture - Virtualization concepts - Storage solutions - Cloud networking and security.

Unit-2
Infrastructure as a Service (IaaS) - IaaS concepts and components - Compute services - Storage services - Networking services - Security and identity services. Platform as a Service (PaaS) - PaaS concepts and components - Application development platforms - Data management services - Middleware services - Integration and deployment services. Software as a Service (SaaS) - SaaS concepts and components - SaaS application examples - SaaS development and delivery.

Unit-3
Cloud Management and Monitoring - Cloud orchestration and automation - Cloud resource management. Cloud-Native Application Development - Microservices architecture - Monolithic vs. microservices architecture - Designing and implementing microservices. Containerization - Docker: container images, registries, and runtimes - Containerizing applications and managing dependencies - Multi-container applications and Docker Compose. Container Orchestration – Overview of platforms - Kubernetes: architecture, components, and concepts - Deploying and managing applications in Kubernetes - Service discovery, scaling, and rolling updates - Alternative orchestration platforms: Docker Swarm.

Textbook(s)
Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall, 2013.
Tom Laszewski, Kamal Arora, Piyum Zonooz, and Erik Farr, "Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud", Packt Publishing, 2018.

Reference(s)
Toby Velte, Anthony Velte, and Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw-Hill Education, 2009.
Michael J. Kavis, "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)", Wiley, 2014.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE364	CYBER-PHYSICAL SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23MATxxx Discrete Mathematics

Course Objectives

This course provides an introduction to CPS, CPS foundations including the symbolic synthesis and modeling paradigms, engineering problems in CPS and applications from various domains.

Course Outcomes

CO1: Understand the fundamentals of cyber-physical systems and analyze their design in different applications.
CO2: Understand and apply the foundations of modeling in CPSs, software-based feedback control and apply them in the context of CPS systems.
CO3: Understand the design of embedded systems for Cyber-Physical Systems (CPS), including sensors and actuators, embedded processors, memory architectures, Input/Output (I/O), multitasking, and scheduling.
CO4: Understand the techniques for analysis and verification for CPS and apply them in different domain applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	3	2	-	-	-	-	-	1	-	-	-	2	2
CO3	3	3	2	-	-	-	-	-	1	-	-	-	2	2
CO4	3	3	-	-	-	-	-	-	1	-	-	-	2	2

Syllabus

Unit 1
Introduction to Cyber-Physical Systems (CPS): Definition, features. CPS Application Domains: Introduction and Motivation, System Description, Operational Scenarios, Design Drivers and Attributes in Medical CPS, Energy CPS, CPS built on WSNs, Robotics and Autonomous Vehicles.

Unit 2
Modelling continuous dynamics behaviour - Actor models, properties of systems, feedback control. Modelling discrete dynamics behaviour - Finite State Machines, Extended State Machines. Hybrid systems - Classes and modal models. Composition of state

machines, concurrent models of computation. Embedded Systems Design for Cyber-Physical Systems: Sensors and actuators, embedded processors, memory architectures, Input/Output, Multitasking, Scheduling.

Unit 3

Analysis and Verification of CPS: Invariants and temporal logic, equivalence and refinement, reachability analysis and model checking, quantitative analysis. Security of CPS: Introduction and Motivation, Attack Model and Counter Measures, System Theoretic Approaches.

Textbook(s)

Lee EA, Seshia SA. "Introduction to embedded systems: A cyber-physical systems approach", MIT Press; 2017.

Reference(s)

Alur R. "Principles of cyber-physical systems",MIT Press; 2015.

Rajkumar R, De Niz D, Klein M. "Cyber-physical systems",Addison-Wesley Professional; 2016.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
*Continuous Assessment (CA)	50	
**End Semester		30 (50 Marks; 2 hours exam)

*CA – Can be Quizzes, Assignment, Projects, and Reports

**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE365	**INTERNET OF THINGS**	**L-T-P-C: 3-0-0-3**

Pre-Requisite(s): 23CSEXXX Embedded Systems and 23CSEXXX Computer Networks

Course Objectives

- This course covers the fundamentals of IoT and provides skills for IoT based product development.
- The skills students acquire in this subject include the selection of sensors, protocols, hardware boards, interfacing, and implementation for product building. Real life case studies are introduced in this course.

Course Outcomes

CO1: Understand the key techniques and theory behind Internet of Things.
CO2: Apply effectively the various enabling technologies (both hardware and software) for IoT.
CO3: Understand the integration of Cloud and IoT , Edge and Fog Computing.
CO4: Apply various techniques for Data Accumulation, Storage and Analytics.
CO5: Design and build IoT system for any one interesting Use case.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2									2	2	3	2
CO2	3	3	2	2	3		3	2	2	2	2	2	3	2
CO3	3	3	2	3	3	2	3	2	2	2	2	2	3	2
CO4	3	3	2	3	3	2	3	2	2	2	2	2	3	2
CO5	3	3	2	3	3	2	3	2	2	2	2	2	3	2

Syllabus

Unit 1

Introduction to M2M, WSN, loT, CPS and Web of Things - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels - Industrial IoT - Case studies with architectural analysis: Smart City - Smart Water - Smart Agriculture - Smart Energy - Smart Healthcare - Smart Transportation – Connected Vehicles- Smart Retail -Smart waste management – Activity Monitoring.

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 / ESP 32. A Case study with any one of the boards and data acquisition from sensors.

Unit 2

Protocols for loT - Data Protocols: HTTP long polling, short polling, SSE, server push, CoAP, webSockets, MQTT, AQMP - infrastructure protocol (IPV4/V6|RPL) - service discovery and management- Identifier in IoT -Connectivity protocols: BLE, ZigBee, WiFi, NB-IoT, LoRa - Device Management Protocols: TR-369, OMA-DM.

Unit 3

Introduction to SDN, SDN for IoT - Cloud and Data analytics- Types of Cloud - loT with cloud challenges - Selection of cloud for loT applications - Fog and Edge computing for loT - Data Handling and IoT Data Analytics - Case study with AWS / AZURE / Adafruit / GCP - security aspects for loT applications.

Textbook(s)

S. Misra, A. Mukherjee, and A. Roy, 2020. "Introduction to IoT". Cambridge University Press, 2020.

Reference(s)

Bahga A, Madisetti V. "Internet of Things: A hands-on approach"; 2015.
Shriram K Vasudevan, Abhishek SN and Sundaram RMD. "Internet of Things", First Edition,Wiley India;2019.
Raj P, Raman AC. "The Internet of things: Enabling Technologies, Platforms, and Use-cases". Auerbach Publications; 2017.
S. Misra, C. Roy, and A. Mukherjee, 2020. "Introduction to Industrial Internet of Things and Industry 4.0". CRC Press
Adrian McEwen. "Designing the Internet of Things", Wiley;2015.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Mid Term Exam	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

Electives in Computer Vision

23CSE371	DIGITAL IMAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces basics of binary, gray scale and color image processing.
- This course concentrates on digital image processing techniques in spatial and frequency domain which are relevant to image enhancement, restoration and segmentation applications.
- This course introduces representation and description of digital images.

Course Outcomes

CO1: Understand fundamental principles of image processing and perform basic operations on pixels.
CO2: Apply the image processing algorithms and filters in spatial domain for image enhancement and restoration.
CO3: Analyze images in the frequency domain and explore the frequency domain filters for image enhancement and restoration.
CO4: Apply segmentation algorithms on Images and analyze their performance for real world applications.
CO5: Apply appropriate representation and perform morphological processing on images.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	3								3	2
CO2	3	3	3	2	3			2	2	2			3	2
CO3	3	3	3	2	3			2	2	2			3	2
CO4	2	3	3	3	3			2	2	2			3	2
CO5	2	2	2	1	3								3	2

Syllabus

Unit 1
Digital Image Fundamentals: Image Acquisition-Image Sampling and Quantization – Intensity Transformations – Histogram Processing – Spatial Filtering for enhancement and restoration. Filtering in Frequency Domain for enhancement and restoration.

Unit 2
Image Segmentation: Edge Detection – Thresholding- Region Based Segmentation, quadtree, Image pyramids, Color image processing. Case study in Deep learning based segmentation: U-Net, Mask-RCNN
.
Unit 3
Image Description- shape and texture descriptors. Morphological Image Processing: Erosion – Dilation – Opening – Closing – Hit-or-Miss Transform. Case Studies from real world applications.

Textbook(s)
Gonzalez RC, Woods RE. "Digital Image Processing". Fourth edition;2017.

Reference(s)
Pratt W K. "Digital Image Processing", Fourth Edition, John Wiley & Sons;2007.
Castleman K R. "Digital Image Processing", Prentice Hall;1996.
Sandipan Dey, "Hands-On Image Processing with Python Expert Techniques for Advanced Image Analysis and Effective Interpretation of Image Data", Packt Publishing, 2018 .
Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins. "Digital Image Processing Using MATLAB®". Prentice Hall; 2004.
Russ JC, Russ JC. "Introduction to Image Processing and Analysis". CRC press; 2007.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester

Mid Term Exam	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE372	**COMPUTER GRAPHICS AND ANIMATION**	**L-T-P-C: 3-0-0-3**

Course Objectives

- This course aims at teaching students about algorithms involved in 2D and 3D computer graphics and animation.
- It gives a clear foundation of the graphic operations performed on 2D objects.
- It enables the students to create 3D realistic objects and generate 2D, 3D animations.

Course Outcomes

CO1: Understand the basic shapes, 2D and 3D viewing in computer graphics.
CO2: Perform geometric transformations on objects.
CO3: Apply graphics algorithms for rendering objects and surfaces.
CO4: Create 3D objects in the graphics environment and render the scene using open-source tools.
CO5: Synthesize 2D and 3D animations using open-source tools.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		2								3	2
CO2	3	3	2	2	3								3	2
CO3	3	3	2	2	3								3	2
CO4	2	3	3	3	3			2	2	2		3	3	2
CO5	2	3	3	3	3			3	3	3		3	3	3

Syllabus

Unit 1
Computer graphics fundamentals –overview of CG pipeline- 2D shapes, clipping, 2D Geometric transformations. Simple Animation with 2D transformations. Three-dimensional viewing: viewing pipeline, projections: parallel projections, perspective projections. 3D transformations

Unit 2
Illumination models and surface rendering – polygon rendering methods: constant intensity shading, Gouraud shading, Phong shading.– color models, Visible surface detection. Creating 3D Graphics scene using open-source tools such as blender: Creating Three-dimensional (3D) objects, creating 3D graphics scene with objects, Textures, cameras and lighting, Rendering the scene created.

Unit 3
Creating 3D animation using open-source tools such as blender: animation – basic keyframing, auto keyframing, creating bones and skeletons and animate their movement, inverse kinematics. Case study in video sequence editing.

Textbook(s)
Hearn D and Baker P. "Computer Graphics Open GL Version", Fourth Edition, Prentice Hall of India; 2013.
Lance Flavell, "Beginning Blender: Open Source 3D Modeling, Animation, and Game Design", Apress,2010
James Chronister, "Blender basics classroom tutorial book", Fourth edition, 2011

Reference(s)
Plastook R A and Kalley G. "Theory and Problems of Computer Graphics", Schaum's Outline Series, TMH;1985.
Foley J D D, Eiener S K and Hughes J.F. "Computer Graphics Principles and Practice", Second Edition, Pearson Education;1996.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Mid Term Exam	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE373	COMPUTER VISION	L-T-P-C: 3-0-0-3

Course Objectives

- The intent of this course is to familiarize the students on the fundamental concepts of Computer Vision and Image Processing.
- This course covers the basis of image formation in a camera and camera calibration under different environment.
- The course covers detection of various image features and matching them across images for practical applications such as image stitching, motion estimation and object tracking.
- The course introduces few deep learning architectures that form the backbone for real world computer vision applications.

Course Outcomes

CO1: Understand the formation of an image in the camera and apply projective transformations, calibration algorithms to model a camera in the real world.
CO2: Understand stereo, multi view geometry concepts and apply algorithms for depth estimation.
CO3: Apply Feature Detection, Descriptors and Matching methods on images.
CO4: Analyze the performance of basic deep learning architectures for computer vision applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	2	1	-	2	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	2	-	-	2	2	2	-	2	3	2
CO4	3	3	2	2	3	-	-	3	3	3	-	2	3	2

Syllabus

Unit 1
Introduction, Image Formation – geometric primitives and transformations, photometric image formation, projective geometry, Camera Geometry, Sensor and Image Model, Camera Extrinsics and Intrinsics, Homogeneous Coordinates, DLT and Camera Calibration. Implementation of camera calibration algorithm using checker board.

Unit 2
Stereo Geometry – Geometry of the Image Pair, Epipolar Geometry, Fundamental matrix and Essential Matrix, Direct Solution for Fundamental and Essential Matrix. Depth estimation from Stereo geometry, Multi-View geometry, Pose estimation. Feature Detection- points and patches, Förstner Operator, edges, lines, corners

Unit 3
Feature Descriptors and Matching – SIFT Features and RANSAC, Feature-Based Alignment - Image Stitching, Dense motion estimation – Optical flow, Kalman Filter. Deep Learning Architectures for computer vision: AlexNet on ImageNet, VGGNet on ImageNet, GoogleNet on ImageNet

Textbook(s)
Szeliski R. "Computer Vision: Algorithms and Applications", Springer. New York. 2010.
David A. Forsyth, "Computer Vision: A Modern Approach", 2nd edition, 2012.
Dr.Adrian Rosebrock, "Deep learning for computer vision with python", PYIMAGESEARCH, 2017.

Reference(s)
R. Hartley and A. Zisserman, "Multiple View Geometry in computer vision," Cambridge University Press, 2000.
Amin Ahmadi Tazehkandi, "Hands-On Algorithms for Computer Vision: Learn how to use the best and most practical computer vision algorithms using OpenCV",Packt Publishing, 2018.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Mid Term Exam	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE374	VIDEO ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- It introduces basic video analysis techniques related to segmentation, object detection and tracking.
- The course also explains how to do video data analysis in a practical manner

Course Outcomes

CO1: Understand and implement algorithms for video processing and video analysis.
CO2: Apply motion-based algorithms for identifying and tracking objects.
CO3: Understand the fundamentals of Data Analysis in Video Data.
CO4: Apply Data Analysis for Video Data through case studies.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	2								3	2
CO2	2	2	2	2									3	2
CO3	3	2	1	3	2							2	3	2
CO4	3	3	2	3	3							2	3	2

Syllabus

Unit 1
Video Basics, Video Segmentation and Keyframe Extraction. Motion estimation and Compensation- Motion Segmentation - Optical Flow Segmentation- Segmentation for Layered Video Representation. Background Modeling-Shadow Detection - Object Detection -Local Features-Mean Shift: Clustering.

Unit 2
Video object tracking: Template matching, Mean-shift tracking, Kalman and Particle Filters, Tracking by detection. Anamoly detection

Unit 3
Data Collection and Management:Case Selection and Validity in Video Data Analysis, Collecting Custom-Made Data,Collecting Ready-Made Data,Triangulation, Data Management,Analyzing Video Data:Coding and concepts,Timing and sequence,Counts and quantifications, Rhythm and turn-taking, Studying Actors

Textbook(s)
Sonka M, Hlavac V, Boyle R. "Image processing, analysis, and machine vision". 4th edition, Cengage Learning; 2015.
Richard Szeliski. "Computer Vision: Algorithms and Applications", Springer; 2021.
Anne Nassauer, Nicolas M. Legewie, "Video Data Analysis", SAGE Publishers, 2022.

Reference(s)
Rafeal C.Gonzalez , Richard E Wood ,"Digital Image processing", 4th edition, person, 2018.
A.MuratTekalp. "Digital Video Processing", Pearson;1995.
Thierry Bouwmans, FatihPorikli, Benjamin Höferlin and Antoine Vacavant, "Background Modeling and Foreground Detection for Video Surveillance: Traditional and Recent Approaches, Implementations, Benchmarking and Evaluation", CRC Press, Taylor and Francis Group; 2014.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Mid Term Exam	20	

Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE375	AUGMENTED AND VIRTUAL REALITY	L-T-P-C: 3-0-0-3

Course Objectives

- Virtual & Augmented Reality radically changes our lives unlike any other technologies in the past. This course has been designed for understanding the critical components of VR/AR systems.
- The course covers topics that help us to design a better VR system by understanding several engineering concepts (hardware, software, perception) that are used in the current VR systems.
- This is an interdisciplinary course involving concepts from computer science, electrical engineering, mechanical engineering, neuroscience, and psychology.

Course Outcomes

CO1: Understand the physiological and psychological aspects of VR systems.
CO2: Apply geometric modeling and transformations to simulate VR/AR.
CO3: Apply drift correction algorithms for tracking systems.
CO4: Apply visual rendering, interface design in VR for extended reality.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2	3	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2	3	2

Syllabus

Unit 1
Introduction, Goals, Definitions, History, Overview: Hardware, sensors, displays, software, virtual world generator, game engines, sensation and perception, human senses, perceptual psychology, psychophysics.
Geometry of Virtual Worlds: Geometric modeling, Transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll, Axis-angle representations, Quaternions, Converting and multiplying rotations, 3D rotation inverses and conversions, Homogeneous transforms, Chain of viewing transforms, Eye transforms, Canonical view and perspective transforms, Viewport transforms.

Unit 2
Visual Physiology: Photoreceptors, Sufficient resolution for VR, Light intensity, Eye movement issues for VR, Neuroscience of vision. Visual Perception: Depth and Motion Perception, Vection, Stroboscopic apparent motion, Vestibular system combining information from multiple cues/senses, Frame rates and displays Tracking Systems: Orientation tracking/IMU integration, Tilt drift correction, Yaw drift correction, Tracking with a camera, Perspective n-point problem, Sensor Fusion, Filtering, Lighthouse approach

Unit 3

Visual Rendering - Overview: Graphical rendering, ray tracing, shading, BRDFs, Shading models, Rasterization, Pixel shading, VR-specific problems, Distortion shading, Post-rendering image warp (time warp), panoramic rendering. Interfaces -overview, Locomotion, Manipulation, System control, Social interaction, Evaluation of VR Systems, Perceptual training, VR sickness, human subjects experimental methods, recommendations and best practices. Metaverse, XR System: Capabilities, Pros, And Cons; Haptic Sensation and Perception, Rendering Haptics, Stereognosis, Sensation and Perception of Other Senses. Case study on open source tools like Intel oneAPI rendering toolkit.

Textbook(s)
Steven M. LaValle ,"VIRTUAL REALITY", Cambridge University Press, 2023
George Mather, "Foundations of Sensation and Perception", Psychology Press, 2016.

Reference(s)
Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of Computer Graphics", A K Peters/CRC Press; 4th Edition, 2018.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Mid Term Exam	20	
Continuous Assessment Theory (*CAT)	10	
Continuous Assessment Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

Electives in Artificial Intelligence

23CSE470	SEMANTIC WEB	L-T-P-C: 3-0-0-3

Course Objectives

- Semantic Web course, an exploration of the evolution of the web towards a more semantic, data-driven ecosystem.
- This course will introduce you to the core concepts and technologies that make web content understandable to machines.
- We'll dive into the details of Resource Description Framework (RDF), Web Ontology Language (OWL), and SPARQL, along with Linked Data principles and Knowledge Graphs.
- Practical examples and exercises will provide you with a robust understanding of the Semantic Web, equipping you with the skills needed to integrate these technologies into your projects and contribute to a more intuitive, intelligent web.

Course Outcomes

CO1: Understand and discuss fundamental concepts, advantages and limits of the semantic web.
CO2: Understand and use ontologies in the context of Computer Science and the semantic web.
CO3: Understand the relationship between Semantic Web and Web 2.0.
CO4: Apply the RDF framework for Semantic Web.
CO5: Understand the concepts of metadata, semantics of knowledge and resource, ontology, and their descriptions in XML-based syntax and web ontology language (OWL).

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	2	-	-	-	-	-	3	2
CO2	3	2	2	2	-	2	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	2	3	-	-	-	2	2	-	-	3	2
CO5	3	1	2	1	3	-	-	-	2	-	-	-	3	2

Syllabus

Unit 1
The World Wide Web - Limitations of Today's Web – The Next Generation Web – Semantic Web - Layers –Semantic Web technologies – Semantics in Semantic Web – XML: Basics – Well-formed and valid Documents – Namespaces - XML schema – Addressing – Querying - Document Object Model (DOM) – XML Applications – XML limitations.

Unit 2
RDF Basic Ideas - RDF Specification – RDF Syntax: XML and Non- XML – RDF elements – RDF relationship: Reification, Container, and collaboration – RDF Schema – Editing, Parsing, and Browsing RDF/XML – Discovering Information – Querying (RQL, SPARQL) – Web Ontology Language (OWL) - Classes, Instances and Properties in OWL - Complex Classes - Property Restrictions - Role Inclusion.

Unit 3
Ontology – Ontology Types – Logic - Description Logics - Rules - Inference and Reasoning - Ontology Engineering: Introduction – Constructing ontologies – Tools used in building and storing ontologies (Sesame, Jena, Protégé, NeOn) – Reusing ontologies – ontology reasoning. The web of data - Data on the web - shallow and deep web - Linked open data - linked data principles - Linked data design - Publishing linked data - Consuming and aggregating linked data.

Textbook(s)
Paul Groth, Frank van Harmelen, Rinke Hoekstra. "A Semantic Web Primer", Third Edition, MIT press; 2012.

Reference(s)
Keet, C. Maria. "An Introduction to Ontology Engineering". University of Cape Town, 2018.

Yu, Liyang. “A developer’s guide to the semantic Web." Second Edition, Springer Science & Business Media, 2014.
John Davies, Rudi Studer, Paul Warren. “Semantic Web Technologies: Trends and Research in Ontology-based Systems”, Wiley & Sons; 2012.
Domingue, John, and Dieter Fensel. “Handbook of semantic web technologies”. Ed. James A. Hendler. Vol. 1. Berlin: Springer, 2011.
Gómez-Pérez, A. Fernández-López, M. Corcho, O. “Ontological Engineering”. Springer Verlag; 2003.
Michael C. Daconta, Leo J. Obrst, Kevin T. Smith. “The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management”, Fourth Edition, Willey Publishing; 2003.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE471	NATURAL LANGUAGE PROCESSING	L-T-P-C: 3-0-0-3

Course Objectives

- This course is devoted to the study of phonological, morphological, and syntactic processing. These areas will be approached from both a linguistic and an algorithmic perspective.
- The course will focus on the computational properties of natural languages and the algorithms used to process them, as well as the match between grammar formalisms and the linguistic data that needs to be covered.

Course Outcomes

CO1: Understand the models, methods, and algorithms of statistical Natural Language Processing (NLP) for common NLP tasks.
CO2: Understand mathematical and statistical models for NLP.
CO3: Understand linguistic phenomena and linguistic features relevant to each NLP task.
CO4: Develop probabilistic models for NLP.
CO5: Apply learning models to NLP tasks such as document summarization, machine translation, sentiment analysis and spell checking

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2									3	2
CO3	3	2	3	2									3	2
CO4	3	1	2	2	3								3	2
CO5	3	1	2	2	3								3	2

Syllabus

Unit 1

Introduction- History of NLP, Study of Human languages, ambiguity, Phases in natural language processing, applications. Textual sources and Formats. Linguistics resources- Introduction to the corpus, elements in the balanced corpus, (examples -TreeBank, PropBank, WordNet, VerbNet, etc.) Word Level analysis - Regular expressions, Morphological parsing, Types of Morphemes. Tokenization, N-grams, Stemming, Lemmatization, Spell checking. Management of linguistic data with NLTK.

Unit 2

Syntactic Analysis – Lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, and spoken language syntax. Parsing- Unification, probabilistic parsing. Part of Speech tagging- Rule-based POS tagging, Stochastic POS tagging, Transformation-based tagging (TBL), Handling of unknown words, named entities, and multi-word expressions.

Semantics Analysis- Meaning representation, semantic analysis, lexical semantics, WordNet -WordNet similarity measures., Synsets and Hypernyms, Word Sense Disambiguation- Selectional restriction, machine learning approaches, dictionary-based approaches.

Unit 3

Discourse- Reference resolution, constraints on co-reference, an algorithm for pronoun resolution, text coherence, discourse structure. Information Retrieval-Types of an information retrieval model, Boolean Model, Vector space model-Word2Vec, BERT, Improving user queries. Machine Translation – EM algorithm - Discriminative learning - Deep representation learning - Generative learning.

Applications of NLP- Machine translation, Document Summarization, sentiment Analysis, ChatGPT4

Textbook(s)

Martin JH, Jurafsky D. "Speech and language processing: An introduction to natural language processing, computational linguistics, and speech recognition". Pearson Publication, Second Edition; 2013.

Reference(s)

James A. "Natural language Understanding", Second Edition, Pearson Education; 2002.
Bharati A., Sangal R., Chaitanya V."Natural language processing: a Paninian perspective", PHI; 2000.
Tiwary U S, Siddiqui T. "Natural language processing and information retrieval". Oxford University Press, Inc.; 2008.
Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit" (O'Reilly 2009, website 2018).

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE472	ARTIFICIAL INTELLIGENCE AND ROBOTICS	L-T-P-C: 3-0-0-3

Course Objectives

- This course aims to make the students understand the basic principles in AI and robotics technologies.
- The students will be able to apply machine learning algorithms for applications using AI and robotics.

Course Outcomes

CO1: Understand the fundamentals of robots and their components.
CO2: Design and develop kinematic operation for a robotic manipulator.
CO3: Understand different algorithms for path planning and navigation.
CO4: Apply AI and Robotics technologies using basic programming and machine learning.
CO5: Understand societal and business impact of AI and Robotics technologies.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1	1	1	2	1	1	3	2
CO2	3	2	3	2	2	2	1	2	1	2	2	2	3	2
CO3	3	2	3	2	3	2	2	2	2	2	2	2	3	2
CO4	3	1	2	3	3	2	2	2	2	2	2	2	3	2
CO5	3	1	2	2	3	1	2	2	2	2	2	2	3	2

Syllabus

Unit 1
Introduction, Actuators and drives, Control components, De-mining Robot: Embedded Robot Controller, I/O Interface, and PWM Amplifiers, control software, sensor inputs, sensors.

Unit 2
Kinematics, differential motion, statics, energy method, hybrid position force control, Non-holonomic systems, dynamics - Translational and Rotational, computed torque control, Transformation, Path Planning, and Trajectories, Time Response of Dynamic Systems, Dynamic Effects of Feedback Control, Control Systems - Artificial Intelligence based optimal control, Applications of Machine Learning and Deep learning in robot navigation.

Unit 3
Numerical Optimization, Dynamic Optimal Control, Parameter Estimation and Adaptive Control, Application of Computer vision in robotics, Tele-robotics and virtual reality.

Textbook(s)
Asada H, Slotine JJ. "Robot analysis and control". John Wiley & Sons; 1986.

Reference(s)
Iosifidis, Alexandros, and Anastasios Tefas, eds. "Deep Learning for Robot Perception and Cognition". Academic Press, 2022.
Yoshikawa, Tsuneo. "Foundations of robotics: analysis and control". MIT press, 2003.
Spong MW. Seth Hutchinson and Mathukumalli Vidyasagar. "In Robot modeling and control"; 2020.
Lynch KM, Park FC. "Modern Robotics". First Edition, Cambridge University Press, 2017.
John JC. "Introduction to robotics: mechanics and control". Third Edition, Pearson publication, 2004.
Kelly A. "Mobile robotics: mathematics, models, and methods". Cambridge University Press; 2013.
Thrun S, Burgard W, Fox D. "Probabilistic robotics". MIT press; 2005.
Siciliano B, Khatib O. "Handbook of robotics. Section kinematic loops";2008.
Richard S. Sutton, Andrew G. Barto, Francis Bach, "Reinforcement Learning: An Introduction", MIT Press, 2018.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester exam		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE473	**NEURAL NETWORKS AND DEEP LEARNING**	**L-T-P-C: 3-0-0-3**

Course Objectives

- This course provides an introduction to deep neural network models and explores applications of these models.
- The course covers feedforward networks, convolutional networks, recurrent and recursive networks, as well as general topics such as input encoding and training techniques.

Course Outcomes

CO1: Understand the learning components of neural networks and apply standard neural network models to learning problems.
CO2: Analyze the learning strategies of deep learning – regularization, generalization, optimization, bias and variance.
CO3: Analyze regular deep learning models for training, testing and validation in standard datasets.
CO4: Apply neural networks for deep learning using standard tools.
CO5: Understand the mathematics for Deep learning.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	-	-	-	-	-	-	-	-	3	2
CO2	3	2	3	2	2	-	-	-	-	-	-	-	3	2
CO3	3	2	3	2	3	-	-	-	-	-	-	-	3	2
CO4	3	1	2	1	2	-	-	-	-	-	-	-	3	2
CO5	3	1	2	1	-	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1
Perceptrons – classification - limitations of linear nets and perceptrons - multi-Layer Perceptrons (MLP); Activation functions - linear, softmax, tanh, ReLU; error functions; Feed-forward networks - Backpropagation - recursive chain rule (backpropagation); Learning weights of a logistic output -Loss functions - learning via gradient descent; Optimization – momentum method; Adaptive learning rates – RMSProp - mini-batch gradient descent; Bias-variance trade off - Regularization - overfitting - inductive bias – drop out - generalization.

Unit 2
Convolutional Neural Networks - Basics and Evolution of Popular CNN architectures; CNN Applications: Object Detection and Localization, Face Recognition, Neural Style Transfer

Recurrent Neural Networks - GRU - LSTM – Transformers Networks; Applications: NLP and Word Embeddings, Attention Models,

Unit 3

Restricted Boltzmann Machine, Deep Belief Networks, Auto Encoders and Applications: Semi-Supervised classification, Noise Reduction, Non-linear Dimensionality Reduction; Introduction to GAN - Encoder/Decoder, Generator/Discriminator architectures; Challenges in NN training - Data Augmentation - Hyper parameter Settings; Transfer Learning - Developing and Deploying ML Models (e.g., Tensor Flow/PyTorch)

Textbook(s)

Ian Goodfellow, Yoshua Bengio and Aaron Courville. "Deep Learning", MIT Press, Second Edition; 2016.

Reference(s)

Koller, D. and Friedman, N. "Probabilistic Graphical Models". MIT Press;2009.
Hastie, T., Tibshirani, R. and Friedman, J. "The Elements of Statistical Learning". Second edition, Springer; 2009.
Bishop, C. M. "Neural Networks for Pattern Recognition". Oxford University Press;1995.
Aggarwal, Charu C. "Neural networks and deep learning." Springer, 2018.

Evaluation Pattern: 70:30

Assessment	Internal	External
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE474	COMPUTATIONAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Course Objectives

- This course gives importance to make the students to understand the concepts of different computational methodologies to bring computational intelligence.
- This course covers learning the basics of Neural Network, Fuzzy Logic and Evolutionary Algorithms.
- This course also enables the student design and implement simple algorithms with Neural Network, Fuzzy Logic and Evolutionary Algorithms.

Course Outcomes

CO1: Understand the nature and purpose of different computational intelligent components.
CO2: Apply neural networks and applications in real-world scenarios.
CO3: Understand fuzzy systems in application scenarios.
CO4: Analyze the working of Evolutionary algorithms in optimization problems.
CO5: Apply Evolutionary approaches to application scenarios.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1	-	-	-	-	-	3	2
CO2	3	2	2	2	2	2	2	-	-	-	-	-	3	2
CO3	3	2	2	2	1	2	2	-	-	-	-	-	3	2
CO4	3	1	2	2	3	1	1	-	-	-	-	-	3	2
CO5	3	1	2	2	3	2	2	-	-	-	-	-	3	2

Syllabus

Unit 1
Brief review – Pitfalls of Traditional AI – Why computational intelligence? – Computational Intelligence concept, Neural Networks – single layer and multilayer, Backpropagation, Radial-Basis Function Networks, Recurrent Neural Networks.

Unit 2
Fuzzy sets, properties, membership function, fuzzy operations. Fuzzy logic and fuzzy inference and applications.
Evolutionary computation – constituent algorithms, Collective Intelligence - Swarm intelligence algorithms – Overview of other bio-inspired algorithms

Unit 3
Hybrid approaches (neural networks, fuzzy logics, genetic algorithm, etc) - Applications of Computational intelligence in Industrial applications, manufacturing and logistics - Fuzzy systems and Evolutionary algorithms.

Textbook(s)
David B Fogel, Derong Liu, James M Keller. "Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation". John Wiley & Sons; 2016
Konar A, 'Computational Intelligence: Principles, Techniques and Applications", Springer Verlat, 2005.

Reference(s)
Siddique, Nazmul, and Hojjat Adeli. "Computational intelligence: synergies of fuzzy logic, neural networks and evolutionary computing". John Wiley & Sons, 2013.
Lam, Hak-Keung, and Hung T. Nguyen, eds. "Computational intelligence and its applications: evolutionary computation, fuzzy logic, neural network and support vector machine techniques". World Scientific, 2012.
Eberhart RC, Shi Y. "Computational intelligence: concepts to implementations". Elsevier; 2007
Karray F, Karray FO, De Silva CW. "Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education", First Edition, Pearson India, 2009.
Engelbrecht AP. "Computational intelligence: an introduction". John Wiley & Sons; 2007.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE475	GENERATIVE AI	L-T-P-C: 3-0-0-3

Course Objectives

- This course covers the mathematical and computational foundations of generative modeling, as well as applications.
- Specific topics include variational autoencoders, generative adversarial networks, autoregressive models such as Transformers, normalizing flow models, information lattice learning, neural text decoding, prompt programming, and detection of generated content.

Course Outcomes

CO1: Understand principles of Generative AI and their applications.
CO2: Analyze Autoencoder and transformer in real-world scenarios.
CO3: Analyze GAN architectures and applications.
CO4: Analyze graphs for probabilistic models.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	0	3	2	2	2	0	0	3	3
CO2	3	3	3	3	3	0	3	2	2	2	0	0	3	3
CO3	3	3	3	3	3	0	3	2	2	2	0	0	3	3
CO4	3	3	3	3	3	0	3	2	2	2	0	0	3	3

Syllabus

Unit 1
Introduction to Generative AI, Autoencoders – Representational power, layer size and depth, Undercomplete autoencoders, Denoising autoencoders, Contractive autoencoders, Variational autoencoders, Case study: Applications of autoencoders in dimension reduction.

Unit 2
Generative Adversarial networks (GAN) – structure and training algorithm, Deep Convolutional GAN, Autoregressive models – Finite memory, long range memory through RNN and CNN, Transformers – Encoder, decoders, scaling laws, Case study: Generative Adversarial Networks-aided Intrusion Detection System.

Unit 3
Structured probabilistic models – Issues of unstructured models, Directed and Undirected Graphs to describe the models, Partition function, separation and D-separation, Conversion of graphs, sampling from graphical models, Case study: Restricted Boltzmann machine.

Textbook(s)
I. Goodfellow, Y. Bengio, and A. Courville, "Deep Learning", MIT Press, 2016.

Reference(s)
Raut, R., Pathak, P. D., Sakhare, S. R., & Patil, S. (Eds.), "Generative Adversarial Networks and Deep Learning: Theory and Applications". CRC Press, 2023.
J. M. Tomcsak, "Deep Generative Modeling", Springer, 2022.
Langr J, Bok V. "GANs in action: deep learning with generative adversarial networks". Manning. 2019.
A. Papoulis and S. U. Pillai, "Probability - Random Variables, and Stochastic Processes", Fourth Edition, McGraw-Hill, 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE476	**CONVERSATIONAL AI**	**L-T-P-C: 3-0-0-3**

Course Objectives

- This course relates the principles and practice of creating AI conversational interface systems.
- This course includes knowledge-rich natural language understanding, multimodal interaction (speech and sketching), principles of dialogue drawn from cognitive science, question-answering, and architectures for building conversational systems.

Course Outcomes

CO1: Understand computational models of dialogue systems.
CO2: Understand architectures for building conversational systems.
CO3: Apply problem-solving dialogue model for question answering.
CO4: Analyze dialogue management and chatbots.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	0	0	2	3	2	0	0	3	3
CO2	3	2	2	2	1	0	0	2	3	2	0	0	3	3
CO3	3	3	3	3	3	0	0	2	3	2	0	0	3	3
CO4	3	3	3	3	3	0	0	2	3	2	0	0	3	3

Syllabus

Unit 1
Introduction to Conversational AI, Principles of dialogue - common ground, sub dialogues, Gricean principles of conversation, Computational models of dialogue systems, Chatbots architectures – Rule-based and Corpus based, Case study: Sounding board

Unit 2
Architecture for dialogue systems: Pipelines behind common assistant programs, collaborative problem-solving model, dialogue acts. cognitive architectures, Question Answering: Sources of knowledge, Case Study: IBM's Deep Q/A approach

Unit 3
Dialog Management and System Evaluation, Dialog Manager Architectures, Natural Language Generation, evaluation of performance, reward propagation. Case study: Social chatbot evaluation

Textbook(s)
Seminck, O., Michael McTear."Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots", Computational Linguistics, 2023.

Reference(s)

Tur, G. and De Mori, R., "Spoken language understanding: Systems for extracting semantic information from speech". John Wiley & Sons. 2011.
Jokinen, K. and McTear, M., "Spoken dialogue systems. Synthesis Lectures on Human Language Technologies", vol. 2, no. 1, 2009.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE477	REINFORCEMENT LEARNING	L-T-P-C: 3-0-0-3

Course Objectives

- This course primarily focuses on training students to frame reinforcement learning problems and to tackle algorithms from dynamic programming, Monte Carlo and temporal-difference learning.
- It involves larger state space environments using function approximation, deep Q-networks and state-of-the-art policy gradient algorithms.

Course Outcomes

CO1: Understand Markov decision process and reinforcement learning.
CO2: Apply AI search, planning, and learning.
CO3: Apply Hierarchical learning techniques.
CO4: Analyze Q-learning and multi-agent systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	2	0	0	2	2	2	0	0	3	3
CO2	3	2	3	3	3	0	0	2	2	2	0	0	3	3
CO3	3	2	3	3	3	0	0	2	2	2	0	0	3	3
CO4	3	2	3	3	3	0	0	2	2	2	0	0	3	3

Syllabus

Unit 1
Introduction to Reinforcement learning, Markov Decision Process (MDP) - Markov Process, Markov Reward Process, Markov Decision Process and Bellman Equations, Partially Observable MDPs, Planning by Dynamic programming (DP) - Policy Evaluation, Value Iteration, Policy Iteration, DP Extensions, model-free prediction and control.

Unit 2

Integrating planning with learning - Model-based RL, Integrated Architecture and Simulation-based Search, Monte-Carlo (MC) Learning, Exploration and exploitation - Multi-arm Bandits, Contextual Bandits and MDP Extensions, integrating AI search and learning - Classical Games: Combining Minimax Search and RL.

Unit 3
Hierarchical RL - Semi-Markov Decision Process, Learning with Options, Deep RL - Proximal Policy Optimization (PPO), Deep Deterministic Policy Gradient (DDPG), Double Q-Learning, Multi-agent RL - Cooperative vs. Competitive Settings, Mixed Setting.

Textbook(s)
Richard S. Sutton and Andrew G. Barto; "Reinforcement Learning: An Introduction"; 2nd Edition, MIT Press, 2018.

Reference(s)
Dimitri P. Bertsekas; "Reinforcement Learning and Optimal Control"; 1st Edition, Athena Scientific, 2019.
Dimitri P. Bertsekas; "Dynamic Programming and Optimal Control (Vol. I and Vol. II)"; 4th Edition, Athena Scientific, 2017.
Csaba Szepesvári; "Algorithms of Reinforcement Learning (Synthesis Lectures on Artificial Intelligence and Machine Learning)", Morgan & Claypool Publishers, 2010.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE478	DRONES AND ROBOTICS	L-T-P-C: 3-0-0-3

Course Objectives

- This course deals with fundamentals of autonomous units from a systems perspective.
- This course includes the basic concepts on Learn Vision-based perception (localization, mapping, object detection and tracking), mission/motion planning, control, resource management.

Course Outcomes

CO1: Understand fundamentals of autonomous drones.
CO2: Apply principles of perception, localization, and mapping.
CO3: Analyze multi-vehicle behavior.
CO4: Analyze Path planning and control.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	0	0	2	2	2	0	0	3	3
CO2	3	3	3	3	2	0	0	2	2	2	0	0	3	3
CO3	3	3	3	3	2	0	0	2	2	2	0	0	3	3
CO4	3	3	3	3	2	0	0	2	2	2	0	0	3	3

Syllabus

Unit 1

Introduction to Autonomous vehicles and drones, Modeling Kinematics and Dynamics – Robot manipulators, Sensors, motors, motor controllers, Translations and rotations, Probabilistic state estimation, Bayes and Kalman filters

Unit 2

Robotics - Robotic perception, Localization and mapping, Machine learning in robot perception, Planning control, path planning and trajectory planning.

Unit 3

Unmanned Aircraft Vehicles, drones - multi-vehicle navigation and behavior, ML and Reinforcement Learning for Autonomous Vehicles.

Textbook(s)

Saha S. K., "Introduction to robotics". Second Edition, Tata McGraw-Hill Education, 2014.

Reference(s)

Barnhart, R. Kurt, Douglas M. Marshall, and Eric Shappee, eds. "Introduction to unmanned aircraft systems". Third Edition, CRC Press, 2021.
Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza (2018), "Introduction to autonomous mobile robots", MIT press.
Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs". Que Publishing, 2016.
Gerhard Weiss, "Multiagent System", Second Edition, MIT Press, 2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
Midterm	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE479	MACHINE LEARNING WITH GRAPHS	L-T-P-C: 3-0-0-3

Course Objectives

- This course aims to equip students with a solid foundation in the theory and applications of machine learning with graphs, as well as practical skills in implementing and applying GNNs to real-world problems.
- By the end of the course, students should be able to understand and use various GNN architectures and techniques to solve graph-based machine learning problems.

Course Outcomes

CO1: Develop an understanding of the theory and applications of machine learning with graphs.
CO2: Gain an understanding of various GNN architectures and techniques.
CO3: Acquire practical skills in implementing and applying GNNs to solve real-world problems.
CO4: Be able to handle large graphs and solve graph-based machine learning problems using GNNs.

CO-PO Mapping

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
CO1	3	3	1	0	1	2	1	0	0	0	0	0	3	2
CO2	3	3	1	0	1	2	1	0	0	0	0	0	3	2
CO3	3	3	1	2	3	2	1	0	0	0	1	1	3	2
CO4	3	3	2	2	3	2	1	0	0	0	0	0	3	2

Syllabus

Unit 1
Introduction to Machine Learning for Graphs, Structure of Graphs, Node Embeddings, Random graphs with arbitrary degree distributions and their applications, Properties of Networks, and Random Graph Models, Motifs and Structural Roles in Networks, Simple Building Blocks of Complex Networks, Community Structure in Networks, Fast unfolding of communities in large networks, Overlapping Community Detection at Scale: A Nonnegative Matrix Factorization Approach, Spectral Clustering, Message Passing and Node Classification, Graph Representation Learning

Unit 2
Theory of Graph Neural Networks, Architectures-GCN, GAT, MPNN & Design Space, Deep Generative Models for Graphs, Link Analysis: PageRank, Network Effects and Cascading Behaviour, Probabilistic Contagion and Models of Influence, Influence Maximization in Networks, Outbreak Detection in Networks, Network Evolution, Reasoning over Knowledge Graphs, Applications of Graph Neural Networks

Unit 3
Efficient Graphlet Kernels for Large Graph Comparison, Semi-Supervised Classification with Graph Convolutional Networks, Inductive Representation Learning on Large Graphs ,Graph Attention Networks, GNN Augmentation and Training, Hierarchical Graph Representation Learning with Differentiable Pooling, Machine Learning with Heterogeneous Graphs, Modeling Relational Data with Graph Convolutional Networks, Heterogeneous Graph Transformer, Advanced Topics in GNNs, Algorithm for Training Deep and Large Graph Convolutional Networks

Textbook(s)
William L. Hamilton, "Graph Representation Learning", McGill University 2020.
David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press (2010).

Reference(s)
Negro, Alessandro. "Graph-powered machine learning". Simon and Schuster, 2021.
Pósfai, Márton, and Albert-Laszlo Barabasi. "Network Science". Cambridge, UK: Cambridge University Press, 2016.

Evaluation Pattern: 70:30

Assessment	**Internal**	**End Semester**
Mid Term Exam	20	
Continuous Assessment – Theory (*CAT)	20	
Continuous Assessment – Lab (*CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE480	AI FOR INDUSTRIAL DECISION-MAKING	L-T-P-C:3-0-0-3

Course Objectives

- This course provides a comprehensive understanding on the AI techniques that are applied to industrial automation problems.
- The topics such as intelligent control systems, multiresolution control architecture and intelligent decision making are covered.

Course Outcomes

CO1: Identify the potential use of AI in industrial automation.

CO2: Elucidate the need and implementation of intelligent control systems.

CO3: Understand the components of multiresolution control architecture.

CO4: Learn the methods for solving industrial problems using distributed artificial intelligence.

CO5: Understand the ethics and standards of industrial decision making through case studies.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	1	1	1	2	1	1	3	2
CO2	3	2	2	3	2	2	1	2	1	2	2	2	3	2
CO3	3	2	2	2	3	2	2	2	2	2	2	2	3	2
CO4	3	1	2	3	3	2	2	2	2	2	2	2	3	2
CO5	3	1	2	2	3	1	2	2	2	2	2	2	3	2

Syllabus

Unit 1

AI in decision making, Qualitative reasoning, Formal concepts and relation, views and phenomena, deriving and reasoning with HPT model, essential features of control systems, concerning time and correct functioning of systems, Q-Model.

Unit 2

Intelligent control system, control system development, phase space navigator, stabilizing, architecture for intelligent control systems, multiresolution control architecture (MCA), MCA in autonomous control system, algorithm for MCA, Complexity of knowledge representation and manipulation.

Unit 3

DAI techniques in manufacturing control, Distributed AI, VerFlex, Neurocontrol architectures, robot neurocontrol, NN based adaptive controller, case study

Textbook(s)

Bhaskar Ghosh, Rajendra Prasad, Gayathri Pallail, "The Automation Advantage: Embrace the Future of Productivity and Improve Speed, Quality, and Customer Experience Through AI", McGraw Hill,2022.

Spyros G. Tzafestas, Henk B. Verbruggen, "Artificial Intelligence in Industrial Decision Making, Control and Automation", Springer Dordrecht, 1995.

Reference(s)

Yadav, Satya Prakash, Dharmendra Prasad Mahato, and Nguyen Thi Dieu Linh, eds. "Distributed artificial intelligence: A modern approach". CRC Press, 2020.

Pascal Bornet, "INTELLIGENT AUTOMATION: Learn how to harness Artificial Intelligence to boost business & make our world more human", 2020.

Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress, 2020.

Berrah, Lamia, and Damien Trentesaux. "Decision-Making in Future Industrial Systems: Is Ethics a New Performance Indicator?." Service Oriented, Holonic and Multi-Agent Manufacturing Systems for Industry of the Future: Proceedings of SOHOMA 2020. Springer International Publishing, 2021.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	20	
Continuous Assessment – Lab (*CAL)	30	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

General Electives

23CSE451	GRAPH MINING	L-T-P-C: 3-0-0-3

Course Objectives

- The course aims at Acquiring basic knowledge in the area of algorithmic graph theory including learning the key concepts of mathematical rigor in the analysis of graph algorithms, and of the efficiency of algorithms.
- It exposes the students to focus on mathematical properties of graphs and networks, as a tool for the design of better algorithms.

Course Outcomes

CO1: Understand the basics of graphs, directed graphs, and weighted graphs, and be able to relate them to practical examples.
CO2: Use effective algorithmic techniques to study basic parameters and properties of graphs.
CO3: Design efficient algorithms for various optimization problems on graphs.
CO4: Use effective techniques from graph theory to approach practical problems in networking and telecommunication

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	3	-	-	-			2	-	3	-	3	2
CO2	2	2	3	2	1	-			2	-	3	-	3	2
CO 3	3	2	3	3	2	-			2	-	3	-	3	2
CO4	3	2	3	2	2	-			2	-	3	-	3	2

Syllabus

Unit 1
Graph clustering: Algorithms for partitioning a graph into well-connected pieces (spectral partitioning, sparsest-cuts, multi-way cuts)-
Distances in graphs: Algorithmic methods for geometric problems in graphs, such as the Traveling Salesperson Problem, Minimum Spanning Trees, Shortest Paths

Unit 2
Flows in graphs: Min-cut/max-flow duality, and its extensions to multi-commodity flows. Applications to divide & conquer. - Graph compression: Methods for representing succinctly large graphs (spectral sparsifiers, vertex sparsifiers, graph spanners)

Unit 3
Graph Clustering and Community Detection: Clustering algorithms for graphs: k-means, spectral clustering, Community detection algorithms: modularity-based, hierarchical clustering, Evaluation metrics for graph clustering
Applications of Graph Mining: Social network analysis, Web mining and, recommendation systems, Biological network analysis, Knowledge graphs and semantic web

Textbook(s)
J. A. Bondy and U. S. R. Murty, "Graph Theory with Applications",2008.

Reference(s)
Richard J Trudeau, "Introduction to Graph Theory", 2017 Edition.
R. Ahuja, L. Magnanti, and J. Orlin, "Network Flows: Theory, Algorithms, and Applications".

Nagiza F. Samatova, William Hendrix, John Jenkins, Kanchana Padmanabhan, Arpan Chakraborty, "Practical Graph Mining",2014.
Xu, R., & Wunsch, D. (2005). "Survey of clustering algorithms". IEEE Transactions on neural networks, 16(3), 645-678.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE452	BUSINESS ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- The course presents an applied approach to data mining concepts and methods using Python software for illustration.
- Students will learn how to implement a variety of popular data mining algorithms to tackle business problems and opportunities.
- It covers both statistical and machine learning algorithms for prediction, classification, visualization, dimension reduction, recommender systems, clustering, text mining, and network analysis.

Course Outcomes

CO1: Apply data mining processes, visualize data spread, and employ various techniques of data reduction such as PCA, build predictive models, and evaluate the models
CO2: Apply feature extraction techniques and design a solution for a classification problem employing Regression, NB Classifier, and Decision trees and their variants
CO3: Apply ARIMA and other forecasting methods in business
CO4: Implement Data Analytics on social networks
CO5: Apply knowledge of text representation for extraction and display of embedded information

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3		3				3	3			3	2
CO2	2		3										3	2
CO3	2		3	3	2				3	3			3	2
CO4	2	1	2		2								3	2
CO5	3	2											3	2

Syllabus

Unit 1

Introduction - Overview of the Data Mining Process - The Steps in Data Mining - Preliminary Steps - Predictive Power and Over fitting - Building a Predictive Model - Data Exploration and Dimension Reduction - Data Visualization - Dimension Reduction - Correlation Analysis - Reducing the Number of Categories in Categorical Variables - Converting a Categorical Variable to a Numerical Variable -Principal Components Analysis - Performance Evaluation - Evaluating Predictive Performance - Judging Classifier Performance.

Unit 2

Prediction and Classification Methods - Multiple Linear Regression - Explanatory vs. Predictive Modeling - Estimating the Regression Equation and Prediction - The k-NN Classifier (Categorical Outcome) - The Naive Bayes Classifier - Classification and Regression Trees - Evaluating the Performance of a Classification Tree - Avoiding Overfitting - Logistic Regression - Neural Nets - Fitting a Network to Data - Discriminant Analysis - Classification Performance of Discriminant Analysis - Combining Methods: Ensembles and Uplift Modeling - Association Rules and Collaborative Filtering - Cluster Analysis - Measuring Distance - Hierarchical (Agglomerative) Clustering - The k-Means Algorithm.

Unit 3

Forecasting Time Series - Descriptive vs. Predictive Modeling. Popular Forecasting Methods in Business - Regression-Based Forecasting - A Model with Trend - A Model with Seasonality - A Model with Trend and Seasonality - Autocorrelation and ARIMA Models - Smoothing Methods - Introduction - Moving Average - Simple Exponential Smoothing – Data Analytics - Social Network Analytics - Directed vs. Undirected Networks - Visualizing and Analyzing Networks - Using Network Metrics in Prediction and Classification -Text Mining - The Tabular Representation of Text: Term-Document Matrix and "Bag-of-Words" - Bag-of-Words vs. Meaning Extraction at Document Level - Preprocessing the Text - Implementing Data Mining Methods-Case Studies.

Textbook(s)

Shmueli G, Bruce PC, Yahav I, Patel NR, Lichtendahl Jr KC. “Data mining for business analytics: concepts, techniques, and applications”, R. John Wiley & Sons; 2017.

Reference(s)

VanderPlas J. “Python data science handbook: essential tools for working with data”. " O'Reilly Media, Inc."; 2016.
McKinney W. “Python for data analysis: Data wrangling with Pandas, NumPy, and IPython”. " O'Reilly Media, Inc."; 2012.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE453	COMPETITIVE PROGRAMMING	L-T-P-C: 3-0-0-3

Course Objectives

- This is an undergraduate-level course that aims to improve the problem-solving and programming skill of the students.
- The pre-requisite for this course is proficiency in at least one programming language, knowledge of the libraries such as C++ STL or Collections, completed courses on Data Structures and Design and Analysis of Algorithms.
- The students will solve problems on online platforms based on their learning from data structures and algorithm courses. They will be competing in the live contests to improve their competitiveness in coding.

Course Outcomes

CO1: Use of programming libraries such as C++ STL or Java Collections for problem-solving
CO2: Apply algorithmic design strategies to solve problems from prominent online judge platforms
CO3: Learn advanced data structures and their applications to problem solving.
CO4: Apply algorithm analysis and optimization techniques to improve the efficiency of algorithms
CO5: Learn and apply the skills learned in the course to effectively tackle competitive-level contests.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	3	-			-	3	-	-	3	2
CO2	1	-	-	-	3	-			-	3	-	-	3	2
CO3	2	3	2	-	3	-			-	3	-	-	3	2
CO4	1	2	2	-	3	-			-	3	2	-	3	2
CO5	2	3	2	-	3	-			-	3	2	-	3	2

Syllabus

Unit 1
Introduction, Tips to be competitive, Problems on linear & non-linear data structures using STL/Collections/libraries, Problems on algorithmic paradigms - divide-and-conquer, greedy, dynamic programming.

Unit 2
Implementation and application of advanced data structures - segment tree, Fenwick tree, suffix tree, suffix array, decision tree. Java BigInteger, Combinatorics – Fibonacci numbers, Binomial coefficients, Catalan numbers, Number theory – prime numbers, GCD, LCM, finding prime factors with optimal trial divisions, working with prime factors, extended Euclid.

Unit 3
Computational geometry – Polygon representation, Plane Sweep Technique, Convex Hull and Algorithm, Duality Transform and Application- checking if polygon is convex, a point is in polygon, cutting polygon with straight line, Point Location and Triangulation, Voronoi diagrams and Delaunay triangulation.

Textbook(s)
Steven Halim and Felix Halim, "Competitive Programming 3 – The New Lower Bound of Programming Contests : Handbook for ACM ICPC and IOI Contestants", Edition 3, 2013.

Reference(s)
Antti Laaksone , "Competitive Programmer's Handbook" , 2018.
Bjarne Stroustrup, "C++ Programming Language", Fourth Edition,2022.
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Fourth Edition.
Ivor Horton, "Using the C++ Standard Template Libraries", 2015 Edition.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE454	CONCURRENT PROGRAMMING	L-T-P-C: 2-0-2-3

Course Objectives

- The course aims to provide fundamentals of concurrency and expose students to the various concurrent frameworks that includes multi-threaded and parallel frameworks.
- Although, the content of the course is centred around Java, the underlying concepts are general and applicable irrespective of the languages.
- The course will provide hands-on exposure to various subtleties in concurrent programming which are key for software developers.

Course Outcomes

CO1: Understand and appreciate the associated with concurrent programming.
CO2: Apply the multi-threaded programming framework of Java on different scenarios.
CO3: Design parallel programming frameworks using Java.
CO4: Understand the use of concurrent data structures and synchronization utilities.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	2	2			3	2	2	-	2	3
CO2	1	1	-	-	3	2			3	2	2	-	2	3
CO3	1	2	2	-	-	2			3	2	2	-	2	3
CO4	1	2	2	-	-	2			3	2	2	-	2	3

Syllabus

Unit 1

Basic concurrency concepts, problems with concurrent applications – data races, deadlocks, live-locks, resource starvation, priority inversion, Designing concurrent applications – analysis-design-implementation-testing-tuning, Java concurrency API – Threads in Java.

Unit 2
Managing lots of threads – basic components of executor framework, serial vs. coarse grained vs. fine grained concurrency with examples, Concurrency in a client/server environment, Callable and Future interfaces, Running tasks divided into phases using Phaser class.

Unit 3
Fork-Join parallel programming framework – Divide-and-conquer, Recursive Action Task, ForkJoinPool, and ExecutorService, Work stealing. Processing massive dataset with Parallel Streams – Concurrent Loader, Concurrent Statistics, Concurrent data structures and synchronization utilities. Overview of testing and monitoring concurrent applications.

Textbook(s)
Javier Fernández González, "Mastering Concurrency with Java 9", Second Edition, Pakt Publishing, 2017.

Reference(s)
Brian Goetz, "Java Concurrency in Practice". Addison Wesley, 2010.
Herbert Schidlt, "Java Complete Reference", Eleventh Edition, Paperback, 2020.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE455	DESIGN PATTERNS	L-T-P-C: 3-0-0-3

Course Objectives

- Demonstration of patterns related to object oriented design.
- Describe the design patterns that are common in software applications.
- Analyze a software development problem and express it.
- Implement a module so that it executes efficiently and correctly.

Course Outcomes

CO1: Understand the common software design problems seen in the development process.
CO2: Demonstrate the use of various design patterns to tackle these common problems.
CO3: Identify the most suitable design pattern to address a given software design problem.
CO4: Analyze existing code for anti-patterns and refactor the code.
CO5: Apply best practices of design principles for software design and development.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	-	-	-	-	-	3	2
CO2	3	2	2	2	1	-	-	-	-	-	-	-	3	2
CO3	3	2	2	2	1	-	-	-	-	3	-	-	3	2
CO4	2	2	2	2	1	-	-	-	-	3	-	-	3	2
CO5	2	2	2	2	1	-	-	-	-	3	-	-	3	2

Syllabus

Unit 1

Introduction to Design Patterns: Significance – Software Design and patterns – Model – View - Controller. Describing Design Patterns, The Catalogue of Design Patterns, Organizing The Cato log, How Design Patterns solve Design Problems, How to Select a Design pattern, How to Use a Design Pattern.

Unit 2

Observer Pattern - Decorator Pattern - Factory Pattern - Singleton Pattern - Command Pattern - Adapter and Facade Patterns - Template Method Pattern - Iterator and Composite Patterns – The State Pattern – The Proxy Pattern – Compound Patterns.

Unit 3

GRASP Patterns and Anti-patterns, Overview of concurrency patterns. Case Study: Use of patterns in the Design of a Modern Web Framework, Design patterns in agile and iterative development

Textbook(s)

Erich Gamma, Richard Helm, Ralph Johnson and John M. Vlissides, "Design Patterns: Elements of Reusable Object Oriented Software", Second Edition, Addison Wesley, 2000

Reference(s)

James W. Cooper, "Java Design Patterns: A Tutorial", Second Edition, Pearson Education, 2003.
Erich Freeman, Elisabeth Robson, Bert Bates and Kathy Sierra "Headfirst Design Patterns", O'Reilly Media Inc., October 2004.
Mark Grand, "Patterns in Java – A Catalog of Reusable Patterns Illustrated with UML", Wiley – Dream tech India, 2002.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE456	DOMAIN SPECIFIC LANGUAGES	L-T-P-C: 3-0-0-3

Course Objectives

- The main objective of the course is to impart a solid overview of the state of the art of today's domain specific languages (DSLs).
- This includes introduction to some existing domain specific languages, their design and implementation.

Course Outcomes

CO1: To understand the basic concepts of Domain specific languages.
CO2: To understand the conceptual foundations of designing Domain specific Languages.
CO3: To understand the implementation of internal and external DSLs.
CO4: Explore some existing DSLs.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	-	3	-	-	-	2	-	2	2	2
CO3	3	3	3	3	-	3	-	-	-	3	-	2	2	2
CO4	3	3	3	3	-	3	-	-	-	3	-	2	2	2

Syllabus

Unit 1
Introduction to DSL
An introductory example. Introduction to DSLs -Terminologies – General Purpose language to DSL - Modelling & Model-driven development – Benefits of using DSL – Challenges – Applications of DSLs. Using Domain-Specific Languages - Defining DSL - DSL Lifecycle - What Makes a Good DSL Design – Differentiation from other approaches.

Unit 2
DSL Design
Conceptual Foundations – Program, Language and Domains – Model Purpose – Structure of Program and Languages – Parsing vs Projection. Design dimensions – Expressivity - Coverage - Semantics and Execution - Separation of Concerns - Completeness - Language Modularity Concrete Syntax. Fundamental Paradigms – Structure – Behavior – Combinations. Process issues – DSL Developments – Using DSLs. Concrete and Abstract syntax.

Unit 3
DSL Implementation
Implementing DSLs - Architecture of DSL Processing - The Workings of a Parser - Grammars, Syntax, and Semantics - Parsing Data – Macros - Testing - Handling Errors - Migrating DSLs. Internal DSL and External DSL implementation. Choosing between internal and external DSL. Alternative computational models - Decision Table - Production Rule System - State Machine - Dependency Network - Choosing a Model. Code generation. A Zoo of DSLs.

Reference(s)
Lorenzo Bettini, "Implementing Domain-Specific Languages with Xtext and Xtend"2nd edition, 2016.
Debasish Ghosh, "DSL in Action", Foreword by Jonas Boner,2010.
Markus Voelter, "DSL Engineering- Designing, Implementing and Using Domain-Specific Languages",2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester

MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE457	**ELEMENTS OF COMPUTING**	**L-T-P-C: 3-0-0-3**

Course Objectives

- The course will expose the students to the basics of Boolean algebra and further help them to understand the workings of a modern computer.
- Students will be trained to build a computing system using elementary logic gates such as NAND, AND, OR etc. through simulation software.
- The course exposes students to a significant body of computer science knowledge, gained through a series of hardware and software construction tasks.

Course Outcomes

CO1: To introduce the implementation of digital logic systems.
CO2: To develop an understanding of the working of a modern computing system.
CO3: Implement and execute low-level programming on the hardware platform.
CO4: Develop and test programs in the object-based language 'Jack'.
CO5: Practice experiments related to basic concepts and functions of operating systems and compilers.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	-	-	-	-	-	2	2	2
CO2	3	2	3	3	3	-	-	-	-	-	-	2	2	2
CO 3	3	3	3	3	3	2	-	-	-	-	3	2	2	2
CO4	3	2	3	3	3	-	-	-	-	-	3	2	2	-
CO5	3	2	3	3	3	-	-	-	-	-	3	2	2	2

Syllabus

Unit 1
Abstraction, Implementation Paradigm – HDL Overview – Implementing Gates in HDL – Combinational Logic: Design and Implement Binary Adders – Simple ALU Construction – Sequential Logic: Design and Implementation of Memory Hierarchy – Implementing Flip Flop Gates, Registers and RAM units of Arbitrary Sizes – Machine Language: Instruction Set (Binary and Assembly Versions) – Writing Low-level Assembly Programs – Running on CPU Emulator

Unit 2
Computer Architecture: Integrating Chip-sets – Building an Assembler – Virtual Machine I: Implementing a VM to translate from VM language into assembly language – Virtual Machine II: Complete VM implementation as the back-end component of Compiler.

Unit 3
High Level Language: Introduction to Jack a high-level object-based language – Compiler I: Building a Syntax analyzer for Jack – Compiler II: Morphing syntax analyzer into a full-scale compiler – Operating System: Design and Implementation of some classical arithmetic and geometric algorithms needed for OS implementation.

Textbook(s)
Noam Nisan and Shimon Schocken, "The Elements of Computing Systems – Building Modern Computers from First Principles", MIT Press, 2008.

Reference(s)
Edward G. Amoroso and Matthew E. Amoroso, "From Gates to Apps", Silicon Press, 2013.
Roger Young, "How Computers Work: Processor and Main Memory", Create space Independent Publishing Platform, Second Edition, 2009.
Charles Petzold, "Code: The Hidden Language of Hardware and Software", Microsoft Press, 2000.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE458	EMBEDDED PROGRAMMING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 23CSEXXX Computer Organization and Architecture

Course Objectives

- The course will stress the importance of embedded systems in modern applications.
- The course will pave the way for understanding the various sources of data streams from an embedded system point of view and recording these data streams for processing.
- This will enable the students to develop various systems and analyze the data from the system for decision-making.
- The course will enable the student with basic real-time operating system concepts for application development.

Course Outcomes

CO1: Enabling the student with fundamentals of micro-controller architecture, building components, and embedded data streaming devices.
CO2: To program various micro-controllers, application development, and data streaming using various sensors.
CO3: Working with Free RTOs for developing real-time data streaming and intelligent applications.
CO4: To develop real-time embedded system applications in healthcare, agriculture, autonomous car, and other data streaming systems.

CO-PO Mapping

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

CO														
CO1	-	3	2	-	2	-	-	-	-	-	-	-	2	2
CO2	-	2	3	-	3	-	-	-	-	-	-	-	2	2
CO3	-	-	2	-	2	3	-	-	-	3	3	-	2	2
CO4	2	3	2	3	3	3	-	-	-	3	3	-	2	2

Syllabus

Unit 1

Hardware and Software Architecture of Embedded Systems. Review of general C programming and data types, arrays, functions, pointers, structure, enum, and files. Introduction to Embedded C, Interfacing C with Assembly. Embedded programming issues - Reentrancy, Portability, Optimizing, and testing embedded C programs.

Unit 2

Embedded Applications using Data structures, Linear data structures– Stacks and Queues, Linked Lists. Embedded C++ and Scripting Languages for Embedded Systems. Software to hardware mapping for a specific architecture.

Unit 3

Introduction to real-time systems, RTOS basic architecture, RTOS Kernel, Kernel services: Task Management -tasks, process and threads, task attributes and types - task states and transition, task control block, Introduction to real-time task scheduling. RTOS for multi-core processors. OS for end and edge devices in cyber-physical systems. Development and debugging and version control tools for Embedded systems.

Textbook(s)

Michael Barr, "Programming Embedded Systems in C and C++", Oreilly Publications, SecondEdition, 2012.

Reference(s)

Brian Amos," Hands-On RTOS with Microcontrollers: Building real-time embedded systems using FreeRTOS, STM32 MCUs, and SEGGER debug tools", PACKT publishing, 15 May 2020.
David E Simon, "An Embedded Software Primer", Pearson Education Asia, 2005.
Wang, K. C. "Embedded and Real-Time Operating Systems", Springer, Cham, 2017. 401-475.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE459	FAULT TOLERANT COMPUTING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- The objective of this course is to identify the requirements of fault tolerant systems, their algorithms and design principles.

Course Outcomes

CO1: To understand the risk of computer failures and their comparison with other equipment failures.
CO2: To understand the different advantages and limits of fault avoidance and fault tolerance techniques.
CO3: To gain knowledge in sources of faults and their prevention and forecasting.
CO4: To analyze fault-tolerant or non-fault-tolerant on the basis of dependability requirements.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1		1	2			2			3	3	2
CO2	3	3	1		1	2			2			3	3	2
CO3	3	3	1	2	1	2			2			3	3	2
CO4	3	3	2	2	3	2			2			3	3	2

Syllabus

Unit 1
Introduction to Fault-Tolerance: Error, Faults and Failures; Reliability and Availability; Dependability Measures. Hardware Fault-Tolerance: Canonical and Resilient Structures; Reliability Evaluation Techniques and Models; Processor-level Fault Tolerance; Byzantine Failures and Agreements.

Unit 2
Information Redundancy: Error Detection/Correction Codes (Hamming, Parity, Checksum, Berger, Cyclic, Arithmetic); Encoding/Decoding circuits; Resilient Disk Systems (RAID). Fault-Tolerant Networks: Network Topologies and their Resilience; Fault-tolerant Routing

Unit 3
Software Fault-Tolerance: Single-Version Fault Tolerance; N-Version Programming; Recovery Approach; Exception and Conditional (Assert) Handling; Reliability Models. Check pointing: Optimal Check pointing; Check pointing in Distributed and Shared-memory Systems.

Textbook(s)
Israel Koren, C. Krishna, "Fault-Tolerant Systems", 2nd Edition, 2020.

Reference(s)
Kishor S. Trivedi, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", John Wiley & Sons Inc., 2016.
P. Jalote, "Fault Tolerance in Distributed Systems", Prentice-Hall Inc. 1994.
D. K. Pradhan, "Fault-Tolerant Computing, Theory and Techniques", Prentice-Hall, 1998.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE460 FEATURES IN MODERN PROGRAMMING LANGUAGES L-T-P-C: 3-0-0-3

Course Objectives

- This course provides a quick overview of different programming languages.
- It focuses primarily on programming using Kotlin, Go and Dart programming languages.

Course Outcomes

CO1: Understand the basic concepts of programming languages (Kotlin, Go, and Dart).
CO2: To use packages, control structures and functions for writing programs using Kotlin, Go and Dart.
CO3: To apply the knowledge on interfaces, exception handling, interoperability and concurrency for programming.
CO4: To solve the real-world problems writing programs using the programming languages Kotlin, Go and Dart.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-			-	-	-	-	2	2
CO2	3	3	3	3	3	-			-	-	-	-	2	2
CO3	3	3	3	3	3	-			-	-	-	1	2	2
CO4	3	3	3	3	3	2			2	2	1	1	2	2

Syllabus

Unit 1
Kotlin
Overview, Basic types, Variables, Control Flow, Array & String, Functions, Collections, OOPs Concept, Exception Handling, Null Safety, Regex & Ranges, Java Interoperability, Kotlin for Android.

Unit 2
Golang
Overview, Basic types, Variables, Control structure, Arrays, Slices, Maps, Functions, Pointers, Structs and interfaces, Concurrency, Packages, Standard Packages.

Unit 3
Dart
Basics, Data Types, Control Flow, Key Functions, Object-Oriented Programming concepts, Dart Utilities, Dart Programs, Exception handling, Collections, Packages. Dart in Flutter Framework.

Note: The choice of languages and the features are subject to modification based on the time of offering the course.

Textbook(s)

Dmitry Jemerov and Svetlana Isakova ,*"Kotlin in Action", Foreword by Andrey Breslav, First Edition, 2017.*
Caleb Doxsey, "An Introduction to Programming in Go", 2012.
Jonathan Sande and Matt Galloway, "Dart Apprentices" first edition, 2021.

Reference(s)

Sanjib Sinha, "Quick Start Guide to Dart Programming", 2020.
Peter Späth "Learn Kotlin for Android Development: The Next Generation Language for Modern Android Apps Programming", 1st ed. Edition, Kindle Edition.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE461	**FULL STACK FRAMEWORKS**	**L-T-P-C: 3-0-0-3**

Course Objectives

- Web development has become easier with the introduction of frameworks.
- It has also paved the way for full stack web development.
- Full-stack developers use frameworks to develop, optimize and maintain websites and other web applications.
- This course covers some of the important full stack frameworks.

Course Outcomes

CO1: Learn how to develop single page applications (SPAs) efficiently using front-end framework.
CO2: Learn to use backend frameworks to develop web and mobile applications robustly.
CO3: Learn to build highly available and scalable internet applications using document databases.
CO4: Design and develop full stack web projects using front-end, back-end and database frameworks.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-			-	-	-	2	2	2
CO2	3	3	-	-	3	3			-	-	-	2	2	2
CO3	3	3	-	-	3	3			-	-	-	2	2	2
CO4	3	3	-	-	3	3			-	-	-	2	2	2

Syllabus

Unit 1
React JS
Creating and using components, bindings, props, states, events, Working with components, Conditional rendering, Building forms, Getting data from RESTful APIs, Routing, CRUD with Firebase, Redux, React and Redux, Function vs. class based components, Hooks.

Unit 2
Express JS
Node JS – Basics, setup, console, command utilities, modules, events, Express JS - Routing, HTTP methods, CSS, Bootstrap, JavaScript, React, Redux, Node, Express, URL building, Templates, Static files, Form data, Database, Cookies, Sessions, Authentication, RESTful APIs, Scaffolding, Error handling, Debugging,

Unit 3
Mongo DB
Mongo DB ecosystem, Importing and Exporting data, Mongo query language, Updating documents, Aggregation framework, System and user generated variables, Scheme validation, Data modelling, Indexing, Performance.

Textbook(s)
Greg Lim, "Beginning React", Paperback, 2020.

Reference(s)
Vasan Subramanian, "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", Paperback, 2017.
Greg Lim, "Beginning Node.js, Express & MongoDB Development", Paperback, 2019.
Shama Hoque, "Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js", 2nd Edition Paperback, 2020.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE462	MULTIMEDIA COMMUNICATION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- This course will discuss different metrics for QoS measurement for multimedia networking applications.
- Understand different compression and protocols for multimedia transmission.

Course Outcomes

CO1: Understand the underlying principles of providing QoS for multimedia networking applications.
CO2: Understand the current image compression and video compression standards.
CO3: Analyze the basic technologies in designing adaptive multimedia applications.
CO4: Analyze the different protocols for multimedia transmission.
CO5: Analyze the current peer-to-peer multimedia networking applications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	1	2							3	2
CO2	3	3	1	1	1	2							3	2
CO3	3	3	1	2	1	2							3	2
CO4	3	3	2	2	3	2							3	2

Syllabus

Unit 1
Fundamentals of networking and multimedia: Internet architecture-layered network design and protocols. Transport layer protocols. Quantization, Analog to digital converter, qualitative requirements needed for multimedia transmission, QoS for multimedia transmission. Image and video compression standards: JPEG image compression, intra-frame coding, inter-frame coding, motion estimation, and motion compensation. Video compression standards and their applications: MPEG2, MPEG4, and H.264.

Unit 2
Adaptation transmission technologies: congestion control, rate control, adaptive encoding, Forward Error Correction (FEC), automatic repeat request (ARQ), and adaptive playback. Protocols suitable for multimedia transmission: Realtime Protocol (RTP), RTP Control Protocol (RTCP), Real-time Streaming Protocol (RTSP), and Session Initiation Protocol (SIP). QoS provision with the network support: DiffServ and IntServ architectures.

Unit 3
Peer-to-peer multimedia applications: networking architectures for multimedia transmission: client/server architecture, multicast, Content Delivery Network, and peer-to-peer networking. Applications based on peer-to-peer networks, including file distribution, voice, and video transmission. File-sharing using Bit Torrent. Skype peer-to-peer VoIP application, and PPlive Internet video broadcasting application.

Textbook(s)
Gregory A. Bassett and Hans W. Barz "Multimedia Networks: Protocols, Design and Applications". Wiley Telecom, 2016.

Reference(s)
Sugata Mitra, Gaurav Bhatnagar, "Introduction to Multimedia Systems (Communications, Networking and Multimedia)", Academic Press, 2001.
Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", 2002.
Parag Havaldar, Gerard Medioni, "Multimedia Systems: Algorithms, Standards, and Industry Practices", Course Technology, 2009.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE463	QUANTUM COMPUTING	L-T-P-C: 3-0-0-3

Course Objectives

- The objective of this course is to provide a strong foundation in quantum computing theory and practical applications.
- It introduces the basic principles of quantum mechanics, qubits, circuit model of quantum computing etc and provides a hands-on experience on programming quantum computer using IBM Qiskit.
- It also includes an introduction to quantum machine learning.

Course Outcomes

CO1: Able to explain the fundamental concepts of quantum mechanics and quantum computing.
CO2: Able to represent quantum states and operations mathematically using Dirac notation and matrix representations.
CO3: Able to design and implement quantum circuits using Qiskit.
CO4: Able to develop simple quantum machine learning solutions.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1					2		1	3	2
CO2	3	3	3	2	3				1	2		2	3	2
CO 3	3	3	3	3	3					2		2	3	2
CO4	3	3	3	3	3	1				2		2	3	2

Syllabus

Unit 1
Quantum Computation: History & Overview, Review of linear algebra: Dirac notation, Hilbert spaces, Unitary, Hermitian, and Normal matrices, Inner product, Outer product, Tensor product, Postulates of Quantum Mechanics, Stern and Gerlach experiment, Qubit, Bloch Sphere

Unit 2
Circuit model of Quantum Computing: Quantum gates and Circuit, Qiskit programming. Entanglement: Bell state, Quantum Teleportation, Superdense coding, Phase kickback, No-cloning theorem, Quantum parallelism, Deutsch-Jozsa algorithm, Bernstein-Vazirani algorithm, Grover search algorithm

Unit 3

Quantum Fourier Transform, Quantum Phase Estimation, Shor's algorithm, Quantum Error Correction, Gottesman-Knill Theorem, Surface codes, Quantum Machine Learning : Data encoding – Basis encoding, Amplitude encoding, Hamiltonian Encoding, Swap test, Q-means clustering.

Textbook(s)

David McMahon, "Quantum Computing Explained", Wiley-IEEE Computer Society Press, 2007.
Maria Schuld, Francesco Petruccione, "Machine Learning with Quantum Computers", Springer International Publications, 2021.
Venkateswaran Kasirajan, "Fundamentals of Quantum Computing -Theory and Practice", Springer, 2021.

Reference(s)

Nielsen MA, Chuang IL. "Quantum computation and quantum information".Cambridge university press;2010 Dec 9.
Eleanor Rieffel and Wolfgang Polak, "Quantum Computing: A Gentle Introduction",2011 Edition, MIT Press.
Chris Bernhardt, "Quantum Computing for Everyone (The MIT Press)",2019.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE464	FORMAL VERIFICATION	L-T-P-C: 3-0-0-3

Course Objectives

- The course aims at teaching students to reason about software verification from a formal standpoint.
- It exposes the students to use tools and techniques to ascertain functional and behavioural correctness for sequential as well as concurrent programs.

Course Outcomes

CO1: Understand the necessity of proving correctness of programs with respect to formal specification.
CO2: Apply program verification techniques to prove and analyze correctness of programs.
CO3: Understand the problems associated with concurrent programs and their effects on their behavioral correctness.
CO4: Understand and use a few state-of-the-art tools to model and verify sequential and concurrent systems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	3	-	-	3	2
CO2	3	2	2	2	2	-	-	-	-	3	2	-	3	2
CO 3	2	1	-	-	1	-	-	-	-	3	2	-	3	2
CO4	3	2	2	2	2	-	-	-	-	3	2	-	3	2

Syllabus

Unit 1
Proving the correctness of sequential programs with respect to a given contract: verification rules and application examples, partial and total correctness. Verification of simple C programs using tools such as Alt-Ergo and Frama-C.

Unit 2
Specifying the input-output contract of a sequential program using logical formulae with bounded quantifiers. Applying the Weakest Preconditions calculus for deriving verification conditions for programs with well-structured control and linear data structures. Formulating loop invariants for iterative programs. Applying the technique for programs such as sorting and searching.

Unit 3
Developing finite-state models for concurrent programs and specifying their behavioural correctness using propositional temporal logic. Defining models using a language such as PROMELA and checking their correctness using SPIN. Applying the technique to check safety properties, such as mutual exclusion and absence of deadlock, and liveness properties such as responsiveness to requests.

Textbook(s)
Allan Blanchard, "Introduction to C program proof with Frama-C and its WP plugin", 2020.

Reference(s)
Huth M, Ryan M. "Logic in Computer Science". Second Edition, Cambridge University Press; 2004.
Jose Bacelar Almeida et al., "Rigorous Software Development: An Introduction to Program Verification", Springer-Verlag London, 2011, ISBN: 978-0-85729- 017-5.
B. Berard et al., "Systems and Software Verification: Model Checking Techniques and Tools", Springer-Verlag, 2001, ISBN: 3-540-41523-8.
Ben-Ari M, "Principles of the Spin model checker", 2008 edition, Springer Science & Business Media; 2008.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE465	MOBILE APPLICATION DEVELOPMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To build beautiful, natively compiled applications for mobile, web, and desktop from a single codebase.

Course Outcomes

CO1: To design Flutter applications using basic UI components.
CO2: To design Flutter applications using Advanced UI components.
CO3: To develop applications to Fetch data from remote server and advanced operations.
CO4: To develop mobile applications with DB connections.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3	-	3	-	-	-	3	3	-	3	2	3
CO2	2	1	3	-	3	-	-	-	3	3	-	3	2	3
CO3	2	2	3	3	3	-	-	-	3	3	-	3	2	3
CO4	2	2	3	3	3	-	-	-	3	3	-	3	2	3

Syllabus

Unit 1
Introduction to dart & flutter – Widgets and their role – Material App – Scaffold – Appbar – Floating Action Button – Text – Centre – Padding - Hot reload and hot restart-Containers – Images from asset and network – Icon – row & column – List view – List tile – Gesture detection - Ink well – Stateless vs staefull widgets – state management – Navigator and routes – Text field – Themes – custom fonts – Grid view – stack – alert dialog.

Unit 2
Advanced widgets – chips,play video, music , Date picker – Time Picker -Future – async – Await – Http –REST API - Model class – json parsing – Displaying remote data – BLoC - GetX - Dynamic dashboards with charts and plots- Push notifications – Animations.

Unit 3
Firebase - Flutter-SQFLite - Influx dB – Connect to MongoDB - Map – GPS Location Information– Sensors – Test and deploy the applications, Multithreading in Android applications.

Textbook(s)
Miola, A. (2020). "Flutter complete reference: Create beautiful, fast and native apps for any device".

Reference(s)
Windmill, E., & Rischpater, R. (2020). "Flutter in action". Manning Publications Co.
Payne, R. (2019). "Beginning app development with flutter: Create cross-platform mobile apps". Apress.
Napoli, M. L. (2020). "Beginning flutter: A hands on guide to app development". John Wiley & Sons.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE466	PARALLEL PROGRAMMING	L-T-P-C: 3-0-0-3

Pre-requisite(s): 23CSEXXX Computer Architecture

Course Objectives

- To expose students to basic techniques of parallel algorithm development and programming on different parallel platform
- To introduce the concepts of programming to minimize run time and development time.
- To develop, analyze, and implement algorithms for parallel computers.

Course Outcomes

CO1: Understand the key parallel computational models, message passing and shared memory paradigms.
CO2: Understand basic principles of performance modeling and optimization and apply memory system optimization techniques.
CO3: Analyze communication and coordination issues in parallel computing.
CO4: Apply parallel programming models for accelerator enhanced computation.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	1	-	-	-	-	3	-	-	3	2
CO2	3	2	2	2	2	-	-	-	-	3	2	-	3	2
CO 3	2	1	-	-	1	-	-	-	-	3	2	-	3	2
CO4	3	2	2	2	2	-	-	-	-	3	2	-	3	2

Syllabus

Unit 1
Introduction From serial to parallel programming- Hardware and software paradigms, Shared infrastructure Parallel Computer Organization, Pipelining and Throughput, Latency and Latency hiding, Memory Organization Inter-process communication.

Unit 2
Basic Parallel Algorithmic Techniques, Pointer Jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated Cascading, Symmetry Breaking, Synchronization (Locked, Lock-free), Deadlock; race conditions. Parallelism in Modern Computing: Multi-core and many-core architectures, Parallel programming for distributed systems and cloud computing ,Heterogeneous computing and accelerators

Unit 3
Parallel Algorithms Sorting algorithms, Algorithms for Broadcast/Reduction and collective operations, Scalability, Distributed Parallel Applications Matrix Multiplication, Interconnection Topologies, Fault Tolerance, Domain decomposition, communication-to-computation ratio, load balancing.
Case study: CUDA, OPENMP

Textbook(s)
Peter S Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, 2011.

Reference(s)
DE Culler, A Gupta and JP Singh, "Parallel Computer Architecture: A Hardware/Software Approach", Morgan-Kaufmann, 1998.
Marc Snir, Steve W. Otto, Steven Huss-Lederman, David W. Walker and Jack Dongarra, "MPI - The Complete Reference", Second Edition, Volume 1, The MPI Core.
William Gropp, Ewing Lusk, Anthony Skjellum, "Using MPI: portable parallel programming with the message-passing interface", 3rd Ed., Cambridge MIT Press, 2014.
A Grama, A Gupta, G Karypis, and V Kumar, "Introduction to Parallel Computing". 2nd Ed., Addison-Wesley, 2003.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports

*CAL – Can be Lab Assessments, Project, and Report

**End Semester can be theory examination/ lab-based examination/ project presentation

Professional Electives for other branches

23CSE431	PRINCIPLES OF ARTIFICIAL INTELLIGENCE	L-T-P-C: 3-0-0-3

Course Objectives

This course provides a comprehensive, graduate-level introduction to artificial intelligence, emphasizing advanced topics such as advanced search, reasoning, decision-making under uncertainty and automated planning.

Course Outcomes

CO1: Develop understanding of the history of artificial intelligence (AI) and its foundations.
CO2: Develop understanding of various applications of AI techniques in intelligent agents and quantifying uncertainty.
CO3: Apply various search strategies and its applicability in advanced AI systems.
CO4: Develop applications in AI language Prolog and Data Mining tool.
CO5: Apply classical planning in various application domains.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1				1		2	3	2
CO2	3	2	3	2	3	2				2		2	3	2
CO3	3	1	2	2	3	2				2		2	3	2
CO4	3	1	2	2	3	2				2		2	3	2
CO5	3	1	2	2	3	2				2		2	3	2

Syllabus

Unit 1
Introduction to AI and systems, Agents and environments-concept of rationality, nature of environment, structure of agents, Search strategies- Uniformed search, Informed search, Local search, Adversarial search, Constrained satisfaction.

Unit 2
Logical Agents-propositional logic, model checking, agent based on propositional logic, First order logic-syntax and semantics of First-Order logic, assertions and queries in First-Order logic, Knowledge engineering in First-Order logic, Inference in First-order logic-forward chaining, Backward chaining, Resolution

Unit 3
Automated planning–algorithm for classical planning, Heuristics planning, planning and acting in nondeterministic domain Classical planning, temporal and resource constrains, uncertain knowledge and reasoning, Ethical and Legal Considerations in AI-Privacy, Bias, AI, Standards in AI systems, Future of AI-emerging development.

Textbook(s)
Stuart Russell & Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice-Hall, Third Edition (2009).

Reference(s)
Patrick Henry, "Artificial Intelligence", Winston Pearson 2002.
National Science and Technology Council, "Preparing for the future of AI," October 2016.
Jerome, J, "Why AI may be the next big privacy trend", 2016.
Ginsberg M. "Essentials of artificial intelligence", Newnes; 2012.
Luger, G. F.,Stubblefield, W. A."Artificial Intelligence - Structures and Strategies for Complex Problem Solving", New York, NY: Addison Wesley, Fifth edition;2005.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE432	PRINCIPLES OF OPERATING SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- The course aims at teaching students understand the structure and implementation of modern operating systems, virtual machines and their applications.
- It summarizes techniques for achieving process synchronization and managing resources like memory and CPU in an operation system.
- It compares and contrasts the common algorithms used for both pre-emptive and non-pre-emptive scheduling of tasks in operating systems (such a priority, performance comparison, and fair-share schemes).
- It gives a broad overview of memory hierarchy and the schemes used by the operating systems to manage storage requirements efficiently.

Course Outcomes

CO1: To understand the architecture and functionalities of modern Operating System.
CO2: To understand and apply the algorithms for scheduling.
CO3: To understand and apply the algorithms for resource management.
CO4: To apply semaphores and monitors for classical and real-world synchronization scenarios.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1										2	2
CO2	2	2	3	2		2							2	2
CO3	2	2	3	2		2							2	2
CO4	2	2	2	2		2							2	2

Syllabus

Unit 1
Introduction to operating systems: Overview – hardware protection – operating systems services – system calls – system structure – virtual machines.

Unit 2
Process concepts – process scheduling – operations on process – inter-process communication – multi threading models – threading issues – thread types – CPU scheduling. Process synchronization: critical section problem – semaphores – classical problems of synchronization —Deadlocks – deadlock characterization – methods of handling deadlocks – deadlock prevention – avoidance – detection and recovery.

Unit 3
Storage management: memory management – swapping – contiguous memory allocation. Paging and segmentation – segmentation with paging – virtual memory – demand paging– page replacement

Textbook(s)
Silberschatz A, Gagne G, Galvin PB. Operating system concepts.Tenth Edition Wiley; 2018.

Reference(s)
Deitel. Deitel, Choffnes. Operating System, Third Edition, Prentice Hall; 2003.
Tanenbaum AS, Bos H. Modern operating systems. Pearson; 2015.
Stevens WR, Rago SA. Advanced programming in the UNIX environment. Addison-Wesley; 2008.
Gary Nutt. Operating Systems, Third Edition, Addison Wesley; 2009.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE433	FUNDAMENTALS OF SOFTWARE ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To introduce basic software engineering concepts
- To introduce the Agile Software development process.
- Hands one training (experiential learning) to digest the concepts learned in the class.
- This is a reading and discussion subject on issues in the engineering of software systems and software development project design.
- It includes the present state of software engineering, what has been tried in the past, what worked, what did not, and why.

Course Outcomes

CO1: Understand the principles of software engineering.
CO2: Understand various software process models.
CO3: Apply the appropriate design methodology for a real-world application.
CO4: Evaluate a system developed for real-world applications in Agile Mode.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1											2	3	2
CO2	2	3	2									2	3	2
CO3	2	1	3			2				1		2	3	2
CO4	2	2	2			3				3		2	3	2

Syllabus

Unit 1
Process Models – overview, Introduction to Agile, Agile Manifesto, principles of agile manifesto, Agile Requirements - User personas, story mapping, user stories, estimating and prioritizing stories, INVEST, acceptance criteria, Definition of Done, Release planning. Key aspects of Scrum: roles - Product Owner, Scrum Master, Team and product backlog Scrum process flow: product backlog, sprints backlog, scrum meetings, demos. How sprint works: Sprint Planning, Daily scrum meeting, updating sprint backlog, Burn down chart, sprint review, sprint retrospective. Scrum Metrics- velocity, burn down, defects carried over.

Unit 2
Traditional process Models: Waterfall, incremental. Requirements Engineering: Tasks Initiation-Elicitation-Developing Use Cases-Building the analysis Model-Negotiation- Validation. Requirements Modelling - building the analysis model, Scenario based methods, UML Models.

Unit 3
Design engineering Design concepts, Design models, software architecture, architectural styles and patterns. Performing user interface Design-Golden Rules-User Interface Analysis and Design- Interface Analysis-Interface design steps.Testing strategies and tactics: Unit testing, integration testing, validation and system testing.

Textbook(s)
Pressman R S, Bruce R.Maxim. "Software engineering - A Practitioner's Approach", Eighth Edition, Tata McGraw Hill, 2014.

Reference(s)
Crowder JA, Friess S. "Agile project management: managing for success". Cham: Springer International Publishing; 2015.
Stellman A, Greene J. "Learning agile: Understanding scrum, XP, lean, and kanban". " O'Reilly Media, Inc."; 2014.
Gregory J, Crispin L. "More agile testing: learning journeys for the whole team". Addison-Wesley Professional; 2014.
Rubin KS. "Essential Scrum: a practical guide to the most popular agile process". Addison-Wesley; 2012.
Cohn M. "User stories applied: For agile software development". Addison-Wesley Professional; 2004.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE434	INTRODUCTION TO BIG DATA ANALYTICS	L-T-P-C: 3-0-0-3

Course Objectives

- The aim of this course is to provide an introduction to big data technologies and tools used for big data.
- Basics of relational databases and its implementation strategy using SQL are discussed in the first phase.
- The second phase discusses on concepts big data and its architecture, storage and processing of data in parallel and distributed system.
- In the last phase retrieval and analysis of unstructured data are done using NOSQL databases.

Course Outcomes

CO1: Understand fundamental concepts of Databases and SQL.
CO2: Apply SQL for data storage and retrieval.
CO3: Understand fundamental concepts of Big Data and its technologies.
CO4: Apply Map reduce programming for big data.
CO5: Analyze appropriate NoSQL database techniques for storing and processing large volumes of structured and unstructured data.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										3	2
CO2	1	3	2										3	2
CO3		2	2	1	3								3	2
CO4		3	2	2	3								3	2
CO5				2	3								3	2

Syllabus

Unit 1
Introduction: Overview of DBMS, File vs DBMS, elements of DBMS, Relational Data Model: Introduction to relational model, Structure of relational mode, domain, keys, tuples to relational models. SQL – table creation, relationships, basic queries DML and DDL, Joins, Grouping.

Unit 2
Introduction to Big Data: Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data-3Vs of Big Data -Terminologies in Big Data - CAP Theorem - BASE Concept. NoSQL: Types of Databases – Advantages – NewSQL - SQL vs. NOSQL vs NewSQL. Introduction to Hadoop: Features – Advantages – Versions - Overview of Hadoop Eco systems - Hadoop distributions - Hadoop vs. SQL – RDBMS vs. Hadoop - Hadoop Components – Architecture – HDFS - Map Reduce: Mapper – Reducer - - Map Reduce: Mapper – Reducer – Combiner – Partitioner. Hadoop 2 (YARN): Architecture - Interacting with Hadoop Eco systems.

Unit 3
No SQL databases: Cassandra: Introduction – Features - Data types – CQLSH - Key spaces - CRUD operations – Collections – Counter – TTL - Alter commands - Import and Export - Querying System tables.

Textbook(s)
Seema Acharya, Subhashini Chellappan. "Big Data and Analytics", Wiley Publication; 2015.

Reference(s)
Hurwitz JS, Nugent A, Halper F, Kaufman M. "Big data for dummies". John Wiley & Sons; 2013.
White T. "Hadoop: The definitive guide", O'Reilly Media, Inc."; 2012.
Bradberry R, Lubow E. "Practical Cassandra: a developer's approach". Addison-Wesley; 2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE435	**FOUNDATION OF INFORMATION TECHNOLOGY**	**L-T-P-C: 3-0-0-3**

Course Objectives

- This course covers the basic concepts in computer science and engineering but not limited to object-oriented programming, database design and software engineering that aids the students of non-CSE to develop applications to solve real world problems.

Course Outcomes

CO1: Understand and Apply the fundamental concepts of Computer System and Computer Programming.
CO2: Apply Object Oriented Paradigm.
CO3: Design Relational Database Management system for a scenario.
CO4: Understand and Apply Software Engineering Principles.
CO5: Apply OOAD principles, Design UML and understand Testing Tools

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2											3	2
CO2	2	2											3	2
CO3	2	2		2									3	2
CO4	2	1											3	2
CO5	2	1											3	2

Syllabus

Unit 1
An Overview of the Computer System-The Parts of a Computer System, Operating System, Input, Output and storage devices, Basics of Networking - Types of Networks and Topology,Introduction to Programming using Scratch and Flowgorithm, Introduction to Object Oriented Paradigm: Abstraction, Encapsulation and Data Hiding, Classes and Objects, Methods, Inheritance and Polymorphism, Introduction to Python programming: Python data variables and operators, Control Structures, Strings, Functions – Built-in functions, User-defined functions and Recursion. Data Structures – List.

Unit 2
Database fundamentals: Data and Need for DBMS, Relational Model and Keys: Data representation and keys in RDBMS, Logical database Design: ER Modeling and notations, Physical Database Design: Converting ER model to Relational Schema. Normalization- Introduction – 1NF, 2NF, 3NF.Implementation with SQL – Introduction, Data types and operators in SQL, SQL statements, Built-in Functions, Group-By and CSE clause, Joins and sub queries. Transaction Management: ACID properties.

Unit 3

Introduction to Software Engineering, UML Diagrams: Object Oriented Analysis and Design, Role of UML in Object Oriented Analysis and Design, UML Building blocks: Structural Things, Behavioral, Grouping and Annotational. Relationships – Dependency, Association, generalization and Realization, UML- Class diagrams, Testing strategies

Textbook(s)

Electronic Resources at http://campusconnect.infosys.com/
Phillips D. "Python 3 Object Oriented Programming". Packt Publishing Ltd; 2010.
Swaroop C H. "A Byte of Python", ebshelf Inc; 2013.
Silberschatz A, Korth HF, Sudarshan S. "Appendix E: Hierarchical Model. Database System concepts", 6th edn. McGraw-Hill. 2010.
Pressman RS. Software engineering: a practitioner's approach. Palgrave Macmillan; 2014.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE436 PRINCIPLES OF DATABASE MANAGEMENT SYSTEMS L-T-P-C: 3-0-0-3

Course Objectives

- This course presents the concepts of database, relational database design, normalization, database-system implementation and maintenance.

Course Outcomes

CO1: Understanding the purpose and architecture of DBMS.
CO2: Design of relational databases and writing SQL and PL/SQL statements to query relational databases.
CO3: Design and build ER models and Relational Schema for sample databases.
CO4: Design and build a normalized database management system for real world databases.
CO5: Understand the principles of transaction processing and concurrency control.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	3	3	-	-	-	-	-	-	-	3	2
CO2	2	3	3	2	3	-	-	-	1	1	-	-	3	2
CO3	2	3	3	2	3	-	-	-	1	1	-	-	3	2
CO4	2	3	3	2	-	-	-	-	3	3	-	-	3	2
CO5	1	1	2	1	2	-	-	-	-	-	-	-	3	2

Syllabus

Unit 1

Introduction:History of database systems - Purpose of Database systems – File Systems Vs Database systems – Database architecture – Different Data models of Database.Relational Data Model: Structure of relational databases – Database schema –

Formal Relational Query Languages. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas.

Unit 2
Relational Database Design: Different Normal forms: 1NF, 2NF, 3NF, BCNF and Higher Normal Forms, Decomposition using Functional Dependencies - Functional Dependency Theory - Multi-valued dependency - SQL: Introduction to SQL – Intermediate SQL.

Unit 3
Transactions: Transaction concept – A simple transaction model - Transaction atomicity and durability - Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, The two-phase locking protocol, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.

Textbook(s)
Silberschatz A, Korth H F, SudharshanS. "Database System Concepts", Sixth Edition, TMH publishing company limited; 2011.

Reference(s)
Đorđević-Kajan S. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, "Database system: The complete book". Prentice Hall; 2nd edition 2008
Elmasri R, Navathe SB. "Fundamentals of Database systems"; 7h Edition Pearson; 2006.
Ramakrishnan R, Gehrke J. "Database management systems". 3rd Edition McGraw Hill; 2007.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE437	PRINCIPLES OF COMPUTER NETWORKS	L-T-P-C: 3-0-0-3

Course Objectives

- This course introduces the foundational principles of computer networks and the layered architecture.
- This course focuses on network layer and transport layer in detail.

Course Outcomes

CO1: To understand the basic concepts of networks, and signals.
CO2: To understand the transmission media and data link layer functionalities.
CO3: To analyze routing protocol and internetworking concepts.
CO4: To configure DNS and HTTP servers.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2									3	2
CO2	3	2		2								2	3	2
CO3	3	3	3	3	2							2	3	2
CO4	3	2	3	2	2							2	3	2

Syllabus

Unit 1
Introduction:-Data communications- Networks- The Internet - Protocols and standards. Network Models:- layered tasks , TCP/IP protocol suite, Addressing. Data and signals:- Analog and digital ,data rate limits, performance. Digital transmission: - digital –to digital conversion, Analog-to-digital conversion, transmission modes.

Unit 2
Transmission media: - guided media – unguided media (wireless). Switching: - Circuit switched networks, datagram networks, virtual circuit networks, structure of a switch. Data link layer - Error detection and corrections: - Introduction, block coding, linear block codes, cyclic codes, checksum. Data link control:- Framing, flow and error control, protocols, noiseless channels, noisy channel. Multiple Access: - Random access, Controlled access, Channelization. Wired LANs – Ethernet: - IEEE standards, Standard Ethernet, changes in the standard, Fast Ethernet, Gigabit Ethernet.

Unit 3
Network layer : IPv4 Addresses, IPv6 Addresses. Internet Protocols: - Internetworking, IPv4, IPv6, transition from IPv4 to IPv6. Transport Layer: process- to – process delivery, user datagram protocol, TCP. Overview of DNS and overview of HTTP.

Textbook(s)
Forouzan AB. "Data communications & networking (sie)". Tata McGraw-Hill Education; 2007.

Reference(s)
Stallings W. "Data and computer communications". Pearson Education India; 2007.
Douglas E. Comer. "Internet working with TCP/IP", Volume -1, Sixth Edition, Addison-Wesley Professional; 2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE438	OBJECT ORIENTED PROGRAMMING	L-T-P-C: 3-0-0-3

Course Objectives

- This course motivates problem solving ability by designing UML and develops the ability to implement the problem using Object-Oriented Paradigm.
- Demonstrates skills to write programs in Java Programming and its Libraries.

Course Outcomes

CO1: Understand Object-Oriented paradigm with concepts of classes, functions, data, and objects.
CO2: Apply the Object-Oriented concepts to design use case driven models for a particular system using UML.
CO3: Develop reusable programs using the concepts of inheritance, polymorphism, interfaces, and packages.
CO4: Apply the concepts of Multithreading and Exception handling to create effective, error-free codes.
CO5: Design interactive programs/applications using Java Collections and swings.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1										3	2
CO2	3	3	2	1									3	2
CO3	1	2	3						2				3	2
CO4	1	1	2	2					2				3	2
CO5	2	2	3	1					2				3	2

Syllabus

Unit 1
Structured to Object Oriented Approach by Examples - Object Oriented languages - Properties of Object Oriented system - UML and Object Oriented Software Development - Use case diagrams as a functional model - Identifying Objects and Representation by Object Diagram -state and behaviour - Identifying classes and CRC Cards -Simple Class using class diagram – Encapsulation - Data Hiding - Reading and Writing Objects - Class Level and Instance Level Attributes and Methods - Generalization using Class Diagram – Inheritance - Constructor and Over Riding – Visibility – Attribute – Parameter – Package - Local and Global

Unit 2
Aggregation and Composition using Class Diagram – Polymorphism – Overloading - Abstract Classes and Interfaces - Exception Handling - Inner Classes - Wrapper classes – String - and String Builder classes – Number – Math – Random - Array methods - File Streams.

Unit 3
Generics - Collection framework - Comparator and Comparable - Vector and Arraylist - Iterator and Iterable - Introduction to Threads - Creating Threads - Thread States - Runnable Threads - Coordinating Threads - Interrupting Threads - Runnable Interface - Swings – Frame Layouts – Widgets - displaying image and graphics.

Textbook(s)
Weisfeld M.,"The object-oriented thought process", Third edition, Addison-Wesley Professional, 2013.
Wampler BE.: "The Essence of Object-Oriented Programming with Java and UML", Addison-Wesley Professional, 2002.

Reference(s)
Deitel PJ. "Java how to program", Eleventh Edition, Pearson; 2018.
Nino J, Hosch FA. "Introduction to programming and object-oriented design using Java", Wiley India Private Limited;2010.
Naughton P. and Schildt H. "Java 2: the complete reference", Eighth Edition, Tata McGraw- Hill; 2011.
Bahrami A. "Object Oriented Systems Development", Second Edition, McGraw-Hill; 2008.
Booch G, Maksimchuk RA. "Object-oriented Analysis and Design with Applications", Third Edition, Pearson Education; 2009.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE439 INTRODUCTION TO DATA STRUCTURES AND ALGORITHMS L-T-P-C: 3-0-0-3

Course Objectives

- To provide understanding of structure and implementation of the common data structures used in computer science and the concept of analyzing algorithms in terms of asymptotic notation.

Course Outcomes

CO1: Understanding of basic data structures.
CO2: Ability to illustrate various operations on data structures.
CO3: Ability to analyze algorithms and check for correctness.
CO4: Ability to analyze application problems and formulate solutions using data structure.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1											3	2
CO2	3	1			1								3	2
CO3	3	1	1		1								3	2
CO4	3	1	1		1								3	2

Syllabus

Unit 1
Introduction: Overview of Data Structures – Philosophy of Data Structures - The Need for Data Structures – Cost and Benefits - Abstract Data Types and Data Structures -Principles, and Patterns. Basic complexity analysis – Best, Worst, and Average Cases - Asymptotic Analysis -Analyzing Programs –Space Bounds, Arrays, Linked Lists and Recursion: Using Arrays - Lists - Array based List Implementation – Linked Lists – LL ADT – Singly Linked List – Doubly Linked List – Circular Linked List - recursion- linear, binary, and multiple recursions. Stacks and Queues: Stack ADT - Array based Stacks, Linked Stacks – Implementing Recursion using Stacks, Queues - ADT, Array based Queue, Linked Queue, Double-ended queue, Circular queue.

Unit 2
Trees: Tree Definition and Properties – Tree ADT - Basic tree traversals - Binary tree - Data structure for representing trees – Linked Structure for Binary Tree – Array based implementation. Priority queues: ADT – Implementing Priority Queue using List – Heaps. Maps and Dictionaries: Map ADT – List based Implementation – Hash Tables - Dictionary ADT - Skip List – Complexity.

Unit 3

Search trees – Binary search tree, AVL tree, Trees – K-D Trees - B-Trees. Sorting and Selection – Linear Sorting – Heap Sort - Divide and Conquer Strategy – Analysis using Recurrence Tree based Method - Merge Sort - Quick Sort -Studying Sorting through an Algorithmic Lens –Selection – External Memory Sorting and Searching. Graphs: ADT Data structure for graphs - Graph traversal- Transitive Closure- Directed Acyclic graphs - Weighted graphs – Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

Textbook(s)
Goodrich M T and Tamassia R, "Data Structures and Algorithms in Java", Fifth edition, Wiley publication, 2010.
Goodrich M T, Tamassia R and Michael H. Goldwasser, "Data Structures and Algorithms in Python++", Wiley publication, 2013.

Reference(s)
Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.
Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE440	ADVANCED ALGORITHMS AND ANALYSIS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): Data Structures and Algorithms

Course Objectives

This course aims to provide the fundamentals of algorithm design and analysis, specifically in terms of algorithm design techniques, application of these design techniques for real-world problem solving and analysis of complexity and correctness of algorithms.

Course Outcomes

CO1: Evaluate the correctness and analyze complexity of algorithms.
CO2: Understand and implement various algorithmic design techniques and solve classical problems.
CO3: Design solutions for real world problems by identifying, applying and implementing appropriate design techniques.
CO4: Design solutions for real world problem by mapping to classical problems.
CO5: Analyze the impact of various implementation choices on the algorithm complexity.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	1								3	2
CO2	3	2	2		1								3	2
CO3	3	2	3	2									3	2
CO4	2	2	3	2									3	2
CO5	2	2	3	1									3	2

Syllabus

Unit 1

Introduction and Review- Algorithms vs. programs. Flow charts and pseudo code, Rate of growth of functions. Review of Asymptotic notation: motivation and types of notations. Recurrence relations and methods to solve them: Recursion tree, substitution, Master Method. Review of Sorting: Bubble –Insertion – Selection – Bucket – Heap, Comparison of sorting algorithms, Applications. Graph Algorithms – Graph Traversal: Applications of BFS: distance, connectivity and connected components and cycles in undirected graphs. Applications of DFS: Topological sort, cycles in directed graphs, Biconnected Components and Strong Connectivity. Path algorithms: Shortest path algorithms (along with analysis) SSSP: Bellman Ford. APSP: Floyd Warshall's. Review of Minimum Spanning Tree (with analysis and applications).

Unit 2

Divide and Conquer: Merge sort and Binary search type strategies, Pivot based strategies – Long integer multiplication – Maximum sub array sum - Closest Pair problem etc as examples. Greedy Algorithm - Introduction to the method, Fractional Knapsack problem, Task Scheduling Problem, Huffman coding etc as examples. Dynamic Programming: Introduction to the method, Fibonacci numbers, 0-1 Knapsack problem, Matrix chain multiplication problem, Longest Common Subsequence, and other problems including problems incorporating combinatorics as examples.

Unit 3

Backtracking, Branch and Bound 0-1 Knapsack, N- Queen problem, subset sum as some examples. String Matching: Rabin Karp, Boyer Moore, KMP. Network Flow and Matching: Flow Algorithms Maximum Flow – Cuts Maximum Bipartite Matching. Introduction to NP class: Definitions P, NP, NP complete, NP hard, Examples of P and NP.

Textbook(s)

Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein. "Introduction to Algorithms". Third Edition, Prentice Hall of India Private Limited; 2009.

Reference(s)

Michael T Goodrich and Roberto Tamassia. "Algorithm Design Foundations - Analysis and Internet Examples". John Wiley and Sons, 2007.

Dasgupta S, Papadimitriou C and Vazirani U. "Algorithms". Tata McGraw-Hill; 2009.

Jon Kleinberg, Eva Tardos. "Algorithm Design". First Edition, Pearson Education India; 2013.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports

*CAL – Can be Lab Assessments, Project, and Report

**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE441	INTRODUCTION TO MACHINE LEARNING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): Linear Algebra, Probability and Random Processes

Course Objectives

- To provide in-depth knowledge of machine learning.
- To facilitate students to learn to implement, train and validate the machine learning models and understand the recent algorithms in machine learning through case studies.

Course Outcomes

CO1: Understand the issues and challenges in machine learning: data, model selection, model complexity
CO2: Design various machine learning algorithms and understand the importance of training and testing the data.
CO3: Design perfect algorithm with the steps involved in designing a machine learning system.
CO4: Analyze the mathematical relationships and identify appropriate Machine Learning algorithms for real world applications.
CO5: Apply the paradigms of supervised and un-supervised learning based on the problem statement.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3									3	2
CO2	3	2	3	2	2								3	2
CO3	3	2	3	2	3								3	2
CO4	3	1	2	1	2								3	2
CO5	3	1	2	1									3	2

Syllabus

Unit 1
Foundations of machine learning - Training, Validation and Testing, Problem of Overfitting & Underfitting, Bias vs Variance, Performance metrics - Regression Vs Classification, Linear Regression, Logistic Regression, Decision Tree, Random Forest, Perceptron, Beyond binary classification.

Unit 2
Advanced supervised learning - Naive Bayes, Bayesian Belief Network, K-Nearest Neighbor, Support vector machines, Markov model, Hidden Markov Model, Neural Networks.

Unit 3
Unsupervised Learning: Curse of Dimensionality, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis Clustering: K-means, Hierarchical, Spectral, subspace clustering, association rule mining.

Textbook(s)
Tom Mitchell. "Machine Learning". McGraw Hill; 2017.

Reference(s)
Christopher M Bishop. "Pattern Recognition and Machine Learning". Springer 2010.
Richard O. Duda, Peter E. Hart, David G. Stork. "Pattern Classification". Wiley, Second Edition;2007.
Kevin P. Murphey. "Machine Learning, a probabilistic perspective". The MIT Press Cambridge, Massachusetts, 2012

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Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE442	DISTRIBUTED SYSTEMS	L-T-P-C: 3-0-0-3

Pre-Requisite(s): Operating Systems, Computer Networks

Course Objectives

- This course is an introduction to the design of large distributed systems and algorithms that support distributed computing.
- It aims to provide a practical exposure into the design and functioning of existing distributed systems.

Course Outcomes

CO1: Understand the fundamental issues in designing distributed systems and be aware of the design principles of distributed systems.
CO2: Apply various distributed algorithms related to clock Synchronization and the need for global state in distributed systems
CO3: Analyze fault tolerance and recovery in distributed systems and algorithms for the same.
CO4: Analyze the design and functioning of existing distributed systems and file systems.
CO5: Design and implement a simple distributed system and implement different distributed algorithms over it.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2		2							3	2
CO2	3	3	2	2		3							3	2
CO3	3	3	2	2		2			2			2	3	2
CO4	3	3	2	2	2	3							3	2
CO5	3	3	3	1	3	3			2	2	2	2	3	2

Syllabus

Unit 1
A Taxonomy of Distributed Systems - Models of computation: shared memory and message passing systems, synchronous and asynchronous systems. Communication in Distributed Systems: Remote Procedure Calls, Message Oriented Communications and implementations over a simple distributed system

Unit 2

Global state and snapshot algorithms. Logical time and event ordering, clock synchronization, Distributed mutual exclusion, Group based Mutual Exclusion, leader election, concurrency control, deadlock detection, termination detection, implementations over a simple distributed system.

Unit 3

Consistency and Replication: Data Centric Consistency, Client Centric Consistency, Replica Management, Consistency Protocols. Fault tolerance and recovery: basic concepts, fault models, agreement problems and its applications, commit protocols, voting protocols, check pointing and recovery. Distributed file systems: scalable performance, load balancing, and availability.
Case Studies: Dropbox, Google FS (GFS)/ Hadoop Distributed FS (HDFS), Bigtable/HBase MapReduce, RDDs, Apache Spark

Textbook(s)

Andrew S. Tannenbaum and Maarten van Steen, "Distributed Systems: Principles and Paradigms", Third Edition, Prentice Hall, 2017.

Reference(s)

Ajay D. Kshemkalyani and Mukesh Singhal, "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2011.
Garg VK, Garg VK. "Elements of distributed computing". John Wiley & Sons; 2002.
George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition, Pearson Education, 2017.
Fokkink W. "Distributed algorithms: an intuitive approach". Second Edition, MIT Press; 2018.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

23CSE443	CLOUD AND IOT	L-T-P-C: 3-0-0-3

Course Objectives

- The focus is to acquaint students with the concepts, techniques and tools related with various enabling technologies of Internet of Things and Cloud Infrastructure.
- With a thorough understanding of a particular domain, the students learn to design IoT end and edge nodes as well integrating them with Cloud infrastructure for application deployment.

Course Outcomes

CO1: Understand the various concepts of the IoT and their technologies.
CO2: Develop the IoT application using different hardware platforms.
CO3: Implement the various IoT Protocols.
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2									3	2
CO2	2	2	2										3	2
CO3	3	3	3	2	2								3	2
CO4	3	3	3	2	2								3	2
CO5	3	3	2	2									3	2

Syllabus

Unit 1
IoT
Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors. Protocols for IoT – Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

Unit 2
Cloud
Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs. IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda – AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security.
Unit 3
Case Study
Case studies with architectural analysis - IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management – Industrial Internet of Things.

Textbook(s)
Bahga A, Madisetti V. "Internet of Things: A hands-on approach"; 2014.

Reference(s)
Shriram K Vasudevan, Abhishek SN and Sundaram RMD. "Internet of Things", First Edition, Wiley India;2019.
Raj P, Raman AC. "The Internet of things: Enabling Technologies, Platforms, and Use-cases". Auerbach Publications; 2017.
Adrian McEwen. "Designing the Internet of Things", Wiley;2013.
Lizhe Wang, Rajiv Ranjan, Jinjun Chen, Boualem Benatallah, "Cloud Computing", CRC Press, 2017.

Evaluation Pattern: 70:30

Assessment	Internal	End Semester
MidTerm Exam	20	
Continuous Assessment – Theory (*CAT)	10	
Continuous Assessment – Lab (*CAL)	40	
**End Semester		30 (50 Marks; 2 hours exam)

*CAT – Can be Quizzes, Assignments, and Reports
*CAL – Can be Lab Assessments, Project, and Report
**End Semester can be theory examination/ lab-based examination/ project presentation

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.

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY

23CHY240	COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Get to understand the structure of molecules using symmetry.
CO2: Understanding Quantum mechanical approach to calculate the energy of a system.
CO3: Applying mathematical knowledge and quantum mechanical approach in finding out the characteristics-reactivity, stability, etc., of the molecule.
CO4: To get a brief idea about molecular mechanics based chemical calculations.CO5: To get an idea about general methodology of molecular modeling.

SyllabusUnit 1
Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Molecular mechanics: Basic theory - Harmonic oscillator – Parameterization - Energy equations - Principle of coupling - Matrix formalism for two masses - Hessian matrix - enthalpy of formation - enthalpy of reactions.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentumMO formation - Operators and the Hamiltonian operator - The quantum oscillator Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2
Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel's MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel's theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel's coefficient matrix - Wheeland's method - Hoffmann's EHTmethod - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3
Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman's theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes
Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

TEXTBOOKS:

1. *K. I. Ramachandran, G Deepa and K Namboori, "Computational Chemistry and Molecular Modeling - Principles and Applications", Springer-Verlag, Berlin, Heidelberg, 2008, ISBN-13 978-3-540-77302-3.*
2. *Donald W Rogers, "Computational Chemistry Using PC", Wiley, (2003).*
3. *Alan Hinchliffe, "Chemical Modeling from atoms to liquids", Wiley, (2005).*

REFERENCES:

1. *James B Forseman and Aeleen Frisch-Gaussian, "Exploring Chemistry with Electronic Structure Method", Inc., Pittsburgh, PA, 2nd edition, (2006).*
2. *A C Philips, "Introduction to Quantum mechanics", Wiley, (2003).*
3. *Wolfram Koch, Max C. Holthausen, "A Chemist's guide to Density Functional Theory", Wiley, VCH, 2nd edition, (2001).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY241	ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics
CO2: Learn the application of the electrochemical principles for the functioning and fabrication of industrial batteries and fuel cells
CO3: Acquire knowledge in solving numerical problems on applied electrochemistry
CO4: Analysis and practical problem solving in fabrication of batteries and fuel cells
CO5: Application of concepts and principle in industrial electrochemical processes
CO6: Evaluation of comprehensive knowledge through problem solving

SyllabusUnit

1
Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation -Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2
Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed)lead acid), nickel-cadmium, nickel-zinc, nickel- metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3
Reserve batteries and Fuel cells: Reserve batteries - water activated, electrolyte activated and thermally activated batteries - remote activation - pyrotechnic materials. Fuel Cells: Principle, chemistry and functioning - carbon, hydrogen- oxygen, proton exchange membrane (PEM), direct methanol(DMFC), molten carbonate electrolyte (MCFC) fuel cells and outline of biochemical fuel cells.

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

TEXTBOOKS:
1. *Derek Pletcher and Frank C. Walsh, "Industrial Electrochemistry", Blackie Academic and Professional, (1993).*
2. *Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, (2001).*

REFERENCES:
1. *Christopher M A, Brett, "Electrochemistry – Principles, Methods and Applications", Oxford University, (2004).*
2. *Watanabe T, "Nano-plating: microstructure control theory of plated film and data base of plated film microstructure", Elsevier, Oxford, UK (2004).*
3. *Kanani N, "Electroplating and electroless plating of copper and its alloy", ASM International, Metals Park, OH and Metal Finishing Publications, Stevenage, UK (2003).*
4. *Lindon David, "Handbook of Batteries", McGraw Hill, (2002).*
5. *Curtis, "Electroforming", London, (2004).*

6. *Rumyantsev E and Davydov A, “Electrochemical machining of metals”, Mir, Moscow, (1989).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY242	FUELS AND COMBUSTION	L-T-P-C: 3-0-0-3

Course Objectives:

To provide the basic knowledge about fuels, rocket propellants and explosives.

Course Outcomes:

CO1:	Understand the types of fuels and variation in their properties
CO2:	Able to analyze the fuel content
CO3:	Obtain knowledge in identifying a proper fuel as per the requirement
CO4:	Ability to know the preparation and working of propellants and explosives

SyllabusUnit

1
Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing -flow test, smoke points, storage and handling.

Secondary liquid fuels - Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Unit 2
Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels forjet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

Unit 3
Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes - Mechanism - ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity, theoretical flame temperature. Combustion calculations, theatrical air requirements, flue gas analysis, combustion kinetics – hydrogen - oxygen reaction and hydrocarbon - oxygen reactions.

Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

TEXTBOOK:

1. *Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009.*

REFERENCES:

1. *Fuels* - *Solids, liquids and gases* - *Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.*
2. *An introduction to combustion: Concept and applications* - *Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.*
3. *Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010*
4. *Engineering Chemistry* - *R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY243	GREEN CHEMISTRY AND TECHNOLOGY	L-T-P-C: 3-0-0-3

Course Objectives:

1. Understand the principles of green chemistry and its contribution to the development of sustainable products
2. Possess knowledge of the migration from a hydrocarbon-based economy to carbohydrate-based economy
3. Evaluate the deficiencies of traditional process and acknowledge the invent of new processes
4. Distinctly map the culmination of academic research to industrial chemistry

Course Outcomes:

CO1: Understand the evolving concept of Green Chemistry and its application to the manufacture of sustainable products
CO2: Appreciate the need for Renewable energy and Feed stock along with carbon sequestration through the fundamentals of Green Chemistry Techniques
CO3: Develop a coherence to evaluate systematic deficiencies in traditional Chemical science process and products
CO4: Undertake a purposeful Journey through the microscopic domain of academic research to the macroscopic domain of Industrial chemistry

Syllabus Unit

1
Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990,USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept ofzero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feed stock, carbon dioxide as a feed stock.

Unit 2
Greener strategies of the synthesis of ibuprofen synthesis, teriphthalic acid etc. phase behaviour and solvent attributes of supercritical CO2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from bio mass, polycarbonate synthesis and CO2 fixation, green plastics, green oxidations, etc.

Unit 3
Processes involving solid catalysts – zeolites, ion exchange resins, Nafion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

REFERENCES:

1. *Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.*
2. *Anastas, P. T., Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press Inc., New York, 1998.*
3. *Matlack, A. S. Introduction to Green Chemistry Marcel Dekker: New York, NY, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY244	INSTRUMENTAL METHODS OF ANALYSIS	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: To develop an understanding of principle and working of the range of instrumental methods in analytical chemistry
CO2: To provide an understanding and skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds
CO3: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.

SyllabusUnit

1
Error Analysis and Sampling: Accuracy - Precision - Classification of Errors -Minimization of errors - Standard deviation - Coefficient of variance - F-test - t-test - Significant figures. Sampling - Basis of sampling, Sampling andphysical state - Safety measures of sampling.

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2
Gas chromatography - principle and applications – gel chromatography.

Electroanalytical techniques: Potentiometry - Potentiometric titration - determination of equivalence point - acidbase, complexometric, redox and precipitation titrations - merits and demerits. Voltammetry - Cyclic voltammetry - basic principle and application - Polarography - introduction - theoretical principles - migration current - residual current - half wave potential - instrumentation - analytical applications.

Unit 3
Spectro-chemical techniques: UV-VIS spetrophotometry - principle - Beer's Law application - photometric titration - single and double beam spectrophotometer - instrumentation of IR - sample handling - IR applications - H - NMR - Instrumentation and applications – principle - instrumentation - applications of atomic absorption spectroscopy.

Thermal and Diffraction techniques: Principles and applications of DTG - DTA DSC - X-ray - Electron DiffractionStudies - SEM, TEM.

TEXTBOOKS:

1. *Willard H W, Merritt J R, "Instrumental Methods of Analysis", 6th edition, Prentice Hall, (1986).*
2. *Skoog Douglas A, West Donald, "Fundamentals of Analytical Chemistry", 7th edition, New York Addison, Wesley, (2001).*

REFERENCES:

1. *"Vogel's Textbook of Quantitative Chemical Analysis", 5th edition, ELBS, (1989).*
2. *Kaur. H, "Instrumental Methods of Chemical Analysis", Goel Publisher, (2001).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY245	BATTERIES AND FUEL CELLS	L-T-P-C: 3-0-0-3

Course Objective:

To provide sound knowledge on the application of electrochemistry in energy storage systems.

Course Outcome

CO1: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics
CO2: Learn the application of the electrochemical principles for the functioning and fabrication industrial batteries and fuel cells
CO3: Analysis of practical problem solving in fabricating batteries and fuel cells
CO4: Evaluation of comprehensive knowledge through problem solving

SyllabusUnit

1
Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicatorand ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler- Volmer equation -Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafelplots - exchange current density and transfer coefficients.

Unit 2
Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3
Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells:Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.

Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen –clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.

TEXTBOOKS:

1. *Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry, (2001).*
2. *M. Aulice Scibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India (2006).*

REFERENCES:

1. *Kanani N, 'Electroplating and electroless plating of copper and its alloy', ASM International, Metals Park,*

OH and Metal Finishing Publications, Stevenage, UK (2003).

2. *Curtis, 'Electroforming', London, (2004).*
3. *F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA, (2005).*
4. *G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL, (2003).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CHY246	CORROSION SCIENCE	L-T-P-C: 3-0-0-3

Course Outcome:

CO1: Development of skill in identifying the nature and type of corrosion
CO2: Understanding the mechanism of various types of corrosion
CO3: Analysing the problem and find out a solution to combat corrosion in any sort of environment.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-
CO2	-	3	1	2	-	-	-	-	-	-	-	1	1	2	-	-
CO3	-	3	3	3	2	3	3	-	-	-	-	1	3	2	3	-

Syllabus Unit

1
Basic principles: Free energy concept of corrosion - different forms of corrosion - Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanicand Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

Unit 2
Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.Corrosion

Inhibitors: Passivators - Vapour phase inhibitor.

Unit 3
Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.

Corrosion protection: Automobile bodies – engines – building construction.

TEXTBOOKS:

1. *Fontana and Mars G, "Corrosion Engineering", 3rd edition, McGraw Hill, (1987).*
2. *Uhlig H H and Reviees R W, "Corrosion and its Control", Wiley, (1985).*

REFERENCES:

1. *ASM Metals Handbook, "Surface Engineering", Vol. 5, ASM Metals Park, Ohio, USA, (1994).*
2. *ASM Metals Handbook, "Corrosion", Vol. 13, ASM Metals Park, Ohio, USA, (1994).*
3. *Brain Ralph, "Material Science and Technology", CRC Series, Boston, New York.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

PHYSICS

23PHY240	ADVANCED CLASSICAL DYNAMICS	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Able to use the Lagrangian formalism to solve simple dynamical system

CO2: Able to understand Hamiltonian formalism and apply this in solving dynamical systems

CO3: Able to apply Lagrangian formalism in bound and scattered states with specific reference to Kepler's laws and Scattering states

CO4: Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of Reference

CO5: Understand and solve problems in rigid body rotations applying of Euler's equations.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO2	3	3	1	1	0	0	0	0	0	0	0	1	0	0	0
CO3	3	3	3	1	0	0	0	0	0	0	0	1	0	0	0
CO4	3	3	3	1	0	0	0	0	0	0	0	2	0	0	0
CO5	3	3	3	2	0	0	0	0	0	0	0	2	0	0	0

SyllabusUnit

1

Introduction to Lagrangian dynamics

Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem

Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square lawof force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite maneouvering and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopicattitude control, gravity- gradient stabilization.

TEXTBOOKS:

1. *H. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 1980, (Second Edition)*
2. *H. Goldstein, Charles Poole, John Safko, Classical Mechanics, Pearson education, 2002 (Third Edition)*
3. *Howard D. Curtis, Orbital Mechanics for Engineering Students, Elsevier, pp.475 - 543*
4. *Anderson John D, Modern Compressible flow, McGraw Hill.*

REFERENCE BOOKS:

1. *D. A. Walls, Lagrangian Mechanics, Schaum Series, McGraw Hill, 1967.*
2. *J. B. Marion and S. T. Thornton, Classical dynamics of particles and systems, Ft. Worth, TX: Saunders, 1995.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY241	ELECTRICAL ENGINEERING MATERIALS	L-T-P-C: 3-0-0-3

Course Outcomes

CO1: To understand the nature of interaction between atoms in crystalline solid materials that determines their dielectric, magnetic and electrical properties.

CO2: Analyze the relation between the macroscopic dielectric constant and the atomic structure of an insulator.

CO3: Fundamental concepts of magnetic fields required to illustrate the magnetic dipoles. This forms the basis to understand the magnetic properties of dia, para, ferro, antiferro and ferri magnetic materials.

CO4: Fundamentals concerned with conduction mechanism in metals and superconductors.

CO5: Understand the basics for classification of materials based on its conductivity, nature of chemical bonds inSi and Ge, carrier density, energy band structure and conduction mechanism in intrinsic and extrinsic semiconductors.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1											1	-
CO2	2	2	2										1	-
CO3	2	2	2										2	-
CO4	2	2	2										2	-
CO5	2	2	2					2					1	-

Syllabus Unit

1

Conducting materials: The nature of chemical bond, crystal structure Ohm’s law and the relaxation time, collisiontime, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it’sconsequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles inmatter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it’s applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor**.**

TEXTBOOK:

1. *A J Decker, "Electrical Engineering materials", PHI, New Delhi, 1957.*

REFERENCES:

1. *A J Decker, "Solid State Physics", Prentice Hall, Englewood Cliffs, N J 1957.*
2. *C Kittel, "Introduction to solid state Physics", Wieley, New York, 1956 (2nd edition).*
3. *Allison, Electronic Engineering materials and Devices, Tata Mc Graw Hill*
4. *F K Richtmyer E H Kennard, John N Copper, "Modern Physics", Tata Mc Graw Hill, 1995 (5th edition).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY242	PHYSICS OF LASERS AND APPLICATIONS	L-T-P-C: 3-0-0-3

Unit 1

Review of some basic concepts and principle of laser.

Introduction to light and its properties: Reflection, refraction, interference, diffraction and polarization. Photometry – calculation of solid angle. Brewster's law. Snell's law and, its analysis.

Introduction to LASERS: Interaction of radiation with matter - induced absorption, spontaneous emission, stimulated emission. Einstein's co-efficient (derivation). Active material. Population inversion – concept and discussion about different techniques. Resonant cavity.

Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of FWHM natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadeningin gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS

Solid state LASER: (i) Ruby LASER – principle, construction, working and application. (ii) Neodymium (Nd) LASERS. gas LASER: (i) He-Ne LASER - principle, construction, working and application. (i) CO2 LASER - principle, construction, working and application.

Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics, semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semi conductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:

Holography: Principle, types, intensity distribution, applications. laser induced fusion. Harmonic generation. LASER spectroscopy. LASERS in industry: Drilling, cutting and welding. Lasers in medicine: Dermatology, cardiology, dentistry and ophthalmology.

REFERENCES:

1. *William T Silfvast, "Laser Fundamentals", Cambridge University Press, UK (2003).*
2. *B B Laud, "Lasers and Non linear Optics", New Age International (P) Ltd., New Delhi.*

3. *Andrews, "An Introduction to Laser Spectroscopy (2e)", Ane Books India (Distributors).*
4. *K R Nambiar, "Lasers: Principles, Types and Applications", New Age International (P) Ltd., New Delhi.*
5. *T Suhara, "Semiconductor Laser Fundamentals", Marcel Dekker (2004).*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY243 CONCEPTS OF NANOPHYSICS AND NANOTECHNOLOGY L-T-P-C: 3-0-0-3

Course Outcomes

CO1: Understand, Comprehend and acquaint with concepts of NanoPhysics
CO2: To familiarize the material's property changes with respect to the dimensional confinements.
CO3: Acquire knowledge on the modern preparation process and analysis involved in the nanomaterial's research
CO4: To learn about the technological advancements of the nano-structural materials and devices in the engineering applications

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												
CO2	2	3												
CO3				3										
CO4						3	2					1		

Syllabus Unit 1

Introduction

Introduction to nanotechnology, comparison of bulk and nanomaterials – change in band gap and large surface to volume ratio, classification of nanostructured materials. Synthesis of nanomaterials - classification of fabrication methods – top down and bottom up methods.

Concept of quantum confinement and phonon confinement

Basic concepts – excitons, effective mass, free electron theory and its features, band structure of solids. Bulk to nano transition – density of states, potential well - quantum confinement effect – weak and strong confinement regime. Electron confinement in infinitely deep square well, confinement in two and three dimension. Blue shift of band gap - effective mass approximation. Vibrational properties of solids - phonon confinement effect and presence of surfacemodes.

Unit 2

Tools for characterization:

Structural – X-ray diffraction, transmission electron microscope,scanning tunneling microscope, atomic force microscope. Optical - UV – visible absorption and photoluminescence techniques, Raman spectroscopy.

Nanoscale materials – properties and applications:

Carbon nanostructures – structure, electrical, vibration and mechanical properties. Applications of carbon nanotubes

Unit 3

Field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement. Quantum dots and Magnetic nanomaterials – applications.

Nanoelectronics and nanodevices:

Impact of nanotechnology on conventional electronics. Nanoelectromechanical systems (NEMSs) – fabrication (lithography) and applications. Nanodevices - resonant tunneling diode, quantum cascade lasers, single electron transistors – operating principles and applications.

TEXTBOOKS:

1. *Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale Science and Technology, John Wiley and Sons Ltd 2004.*
2. *W. R. Fahrner (Ed.), Nanotechnology and Nanoelectronics, Springer 2006.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY244	PHYSICS OF SEMICONDUCTOR DEVICES	L-T-P-C: 3-0-0-3

Course Outcomes:

CO1: Understand, comprehend and acquaint with the basics working principles and governing equations of electronic devices like diodes, Bipolar junction transistors, Mosfet and heterojunction transistors
CO2: Analyze and Solve physics problems pertaining to various process like charge conduction across semiconductor device.
CO3: Apply the knowledge for the development and design of new methods to determine semiconductor parameters and devices

SyllabusUnit

1

Introduction: Unit cell, Bravais lattices, crystal systems, crystal planes and Miller indices, symmetry elements. Defects and imperfections – point defects, line defects, surface defects and volume defects

Electrical conductivity: Classical free electron theory – assumptions, drift velocity, mobility and conductivity, drawbacks. quantum free electron theory – Fermi energy, Fermi factor, carrier concentration. Band theory of solids –origin of energy bands, effective mass, distinction between metals, insulators and semiconductors.

Unit 2

Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors, carrier concentration in intrinsic and extrinsic semiconductors, electrical conductivity and conduction mechanism in semiconductors, Fermi level in intrinsic and extrinsic semiconductors and its dependence on temperature and carrier concentration. Carrier generation - recombination, mobility, drift-diffusion current. Hall effect.

Theory of p-n junctions – diode and transistor:p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, current, electric field, barrier potential. V-I characteristics, junction capacitance and voltage breakdown.

Unit 3

Bipolar junction transistor, p-n-p and n-p-n transistors: principle and modes of operation, current relations. V-I characteristics. Fundamentals of MOSFET, JFET. Heterojunctions – quantum wells.

Semiconducting devices: Optical devices: optical absorption in a semiconductor, e--hole generation. Solar cells – p-n junction, conversion efficiency, heterojunction solar cells. Photo detectors – photo conductors, photodiode, p-i-n diode. Light emitting diode (LED) – generation of light, internal and external quantum efficiency.

Modern semiconducting devices: CCD - introduction to nano devices, fundamentals of tunneling devices, design considerations, physics of tunneling devices.

TEXTBOOKS:

1. *C Kittel, "Introduction to Solid State Physics", Wiley, 7th Edn., 1995.*
2. *D A Neamen, "Semiconductor Physics and Devices", TMH, 3rd Edn., 2007.*

REFERENCES:

1. *S M Sze, "Physics of Semiconductor Devices", Wiley, 1996.*
2. *P Bhattacharya, "Semiconductor Opto- Electronic Devices", Prentice Hall, 1996.*
3. *M K Achuthan & K N Bhat, "Fundamentals of Semiconductor Devices", TMH, 2007.*
4. *J Allison, "Electronic Engineering Materials and Devices", TMH, 1990.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23PHY245	ASTROPHYSICS	L-T-P-C: 3-0-0-3

Course Outcomes:

After completion of the course students should be able to
CO1: Get a broad knowledge of scientific and technical methods in astronomy and astrophysics.
CO2: Apply mathematical methods to solve problems in astrophysics.
CO3: Develop critical/logical thinking, scientific reasoning and skills in the area of modern astrophysics.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	2	2												
CO3	1	2												

SyllabusUnit

1
Historical introduction: Old Indian and western – astronomy - Aryabhatta, Tycho Brahe, Copernicus, Galileo - Olbers paradox - solar system – satellites, planets, comets, meteorites, asteroids.

Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris. Celestial

mechanics - Kepler's laws - and derivations from Newton's laws.

Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2
Stellar astronomy: H-R diagram, color-magnitude diagram - main sequence - stellar evolution – red giants, white dwarfs, neutron stars, black holes - accretion disc - Schwartzchild radius - stellar masses Saha–Boltzman equation -derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds - Nebulae.

Unit 3
Galactic astronomy: Distance measurement - red shifts and Hubble's law – age of the universe, galaxies – morphology - Hubble's classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.

Relativity: Special theory of relativity - super-luminal velocity - Minkowski space - introduction to general theory of relativity – space - time metric, geodesics, space-time curvature. Advance of perihelion of Mercury, gravitational lens.

Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleo-synthesis - planklength and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

REFERENCES:

1. *"Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.*
2. *William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977*
3. *Bradley W. Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.*
4. *Bradley W. Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison-Wesley*

Publishing Company,1996

5. *'Stellar Astronomy' by K. D Abhayankar.*
6. *'Solar Physics' by K. D Abhayankar.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

MATHEMATICS

23MAT240	STATISTICAL INFERENCE	L-T-P-C: 3-0-0-3

Syllabus

Unit 1
Introduction to Statistics: Data Collection and Descriptive Statistics, Populations and Samples, describing data sets, summarizing data sets, Normal Data Sets, Paired Data Sets and the Sample Correlation Coefficient. Review of Random Variables and Distributions, Distributions of Sampling Statistics, The Sample Mean, The Central Limit Theorem, The Sample Variance, Sampling Distributions from a Normal Population, Distribution of the Sample Mean, Joint Distribution of $\bar{X}$ and S^2, Sampling from a Finite Population.

Unit 2
Parameter Estimation: Introduction, Maximum Likelihood Estimators, Interval Estimates, Estimating the Difference in Means of Two normal populations, Approximate Confidence Interval for the Mean of a Bernoulli random variable, Confidence Interval of the Mean of the Exponential Distribution, Evaluating a Point Estimator, The Bayes Estimator. Hypothesis Testing: Introduction, Significance Levels, Tests Concerning the Mean of a Normal Population, Testing the Equality of Means of Two Normal Populations, Hypothesis Tests Concerning the Variance of a Normal Population, Tests Concerning the Mean of a Poisson Distribution.

Unit 3
Regression: Introduction, Least Squares Estimators of the Regression Parameters, Distribution of the Estimators, Statistical Inferences about the Regression Parameters, the Coefficient of Determination and the Sample Correlation Coefficient, Analysis of Residuals, transforming to Linearity, Weighted Least Squares, Polynomial Regression, Multiple Linear Regression, Predicting Future Responses, Logistic Regression Models for Binary Output Data.

TEXTBOOK:

1. Ross S.M., Introduction to Probability and Statistics for Engineers and Scientists, 3rd edition, Elsevier Academic Press.

REFERENCES:

1. *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, John Wiley and Sons Inc., 2005*
2. *Ravichandran, J. Probability and Statistics for engineers, First Reprint Edition, Wiley India, 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. *Hogg, R.V., Tanis, E.A. and Rao J.M., Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAT241	INTRODUCTION TO GAME THEORY	L-T-P-C: 3-0-0-3

Syllabus

Unit 1
Elements of Game theory, examples, Strategic Games, 2 Player Strategy Games, payoffs, Minimax, Weak and Strong Domination, Saddle Points, Nash Equilibrium, Prisoner's Dilemma, Stag Hunt, Matching pennies, BOS, Multi NE, Cooperative and Competitive Games, Strict and Non Strict NE, Best response functions for NE.

Unit 2
Combinatorial games, Winning and losing positions, Subtraction Game, 3-Pile and K-Pile Games, Proof of Correctness, Variations of K-Pile Games, Graph Games, Construction, Proof of finiteness, SG theorem for sum ofgames.

Unit 3
Cournot's Oligopoly, Bertrand's Oligopoly, Electoral Competition, Median Voter Theorem, Auctions, role of knowledge, Decision making and Utility Theory, Mixed Strategy Equilibrium, Extensive Games with Perfect Information, Stackelberg's model of Duopoly, Buying Votes, Committee Decision making, Repeated Gmes, Prisoner's Dilemma, Supermodular Game and Potential games

TEXTBOOK:

1. Martin Osborne, An Introduction to Game Theory, Oxford University Press.

REFERENCES:

1. *Thomas Ferguson, Game Theory, World Scientific, 2018.*
2. *Stef Tijs. Introduction to Game Theory, Hindustan Book Agency.*
3. *Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis Lectures On Communications.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAT242	NUMERICAL METHODS AND OPTIMIZATION	L-T-P-C: 3-0-0-3

Syllabus

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

09 (b) Interpolations:
Interpolation and Approximation: Lagrange, Newton's Divided Difference, Newton's Forward and Backward interpolations.

07 (b) Multivariable optimization (2 Credits)
Optimality criteria – unidirectional search – direct search methods – gradient based methods. Lagrangian and Kuhn-Tucker conditions.

TEXTBOOK:

1. *Edwin K.P. Chong, Stanislaw H. Zak, "An introduction to Optimization", 2nd edition, Wiley, 2013.*
2. *M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for scientific and Engineering computation, New Age International Publishers, 2007, 5th edition.*

REFERENCES:

1. *Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2002.*
2. *S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAMCOMMON TO ALL PROGRAMS

23MNG331	**FINANCIAL MANAGEMENT**	**L-T-P-C: 3-0-0-3**

Course Objectives

- Understand the overview of financial management
- Inculcate methods and concepts on valuation
- Familiarize with working capital management, financial analysis and planning

Course Outcomes

CO1: Understand and apply time value concept of money and use this for investment criteria decisions.
CO2: Evaluate the risk and return for various alternatives of investment.
CO3: Apply the capital budgeting techniques and evaluate the investment decisions.
CO4: Understand working capital management, cash and liquidity management and financial statements**. CO/PO**

Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3					1	1		3	3	1			
CO2	3	3					2	1		3	3	1			
CO3	3	2					1	1		3	3	1			
CO4	3	2			1		2	1	2	3	3	1			

SyllabusUnit

1
Introduction: Financial Management an overview – Financial Decisions in a firm – Goal of FM – Function of the financial system.

Unit 2
Fundamental Valuation Concepts:Time value of money – Risk and Return. Capital Budgeting: Techniques of capital budgeting investment criteria– NPV – Benefit Cost Ratio – IRR – Payback Period – ARR – Investment appraisal inPractice – Estimation of Project cost flows.

Unit 3
Working Capital Management: Current Assets – Financing Ruling – Profit Criterion. Cash and Liquidity Management. Working Capital Financing.

Financial Analysis and Planning**:** financial instruments, sources of long-term, intermediate term and short term finance. Analyzing Financial Performance – Break – even analysis and Leverages – Financial Planning and Budgeting.

Mergers and Takeovers-International trade.

TEXT BOOKS

1. *Chandra, P., 'Financial Management: Theory and Practice', 9e, TMH, 2017.*
2. *Denzil Watson & Antony Head, 'Corporate Finance- Principles and Practice', 2e, Pearson Education Asia, 2016.*
3. *R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.*

REFERENCE BOOKS

1. *Stephen Blyth, 'An Introduction to Corporate Finance ',McGraw Hill Book Company, 2014.*
2. *Eugene F. Brigham & Louis C.Gapenski, 'Financial Management – Theory and Practice',14e, 2015.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG332	SUPPLY CHAIN MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- Understand the complexity and key issues in supply chain management.
- Describe logistics networks, distribution planning, routing design and scheduling models.
- Familiarize dynamics of supply chain and the role of information in supply chain.
- Understand the issues related to strategic alliances, global supply chain management, procurement and outsourcing strategies.

Course Outcomes

CO1: Analyze the complexity and key issues in supply chain management
CO2: Evaluate single and multiple facility location problems, logistics network configuration, vehicle routing and scheduling models
CO3: Analyze inventory management models and dynamics of the supply chain
CO4: Develop the appropriate supply chain through distribution requirement planning and strategic alliances
CO5: Identify the issues in global supply chain management, procurement and outsourcing strategies

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1									1	3		
CO2	2	2	3	1						1	1	2	2		
CO3	3	3	3	3	2				3	1	1	3	2		
CO4	2	2	1	1						1	1	2	2		
CO5	3	3	3	1					3	1	1	3	2		

SyllabusUnit

1
Introduction: Introduction to SCM-the complexity and key issues in SCM – Location strategy – facility locationdecisions – single facility and multiple location models.
Logistics: Logistics Network Configuration – data collection-model and data validation- solution techniques-network configuration DSS – Transport strategy – Service choices: single service and inter modal services – vehicle routingand scheduling models – traveling salesman problems – exact and heuristic methods.

Unit 2
Inventory: Inventory Management and risk pooling-managing inventory in the SC. Value of Information-bullwhipeffect-lead time reduction.
Supply Chain Integration: Supply chain integration-distributed strategies-push versus pull systems. Distribution Requirements Planning – DRP and demand forecasting, DRP and master production scheduling. DRP techniques –time-phased order point – managing variations in DRP – safety stock determination-Strategic alliances-third partylogistics-distribution integration.

Unit 3
Issues in SCM**:** Procurement and outsourcing strategies – framework of e-procurement. International issues in SCM-regional differences in logistics. Coordinated product and supply chain design-customer value and SCM.

TEXT BOOK
Simchi-Levi,D.,Kaminsky,P.,Simchi-Levi,E., Shankar,R., ‘Designing and Managing the Supply Chain: Concepts, Strategies, and Cases’, Tata McGraw Hill, 2008.

REFERENCE BOOKS

1. *Christopher, M., 'Logistics and Supply Chain Management: Strtegies for reducing Cost and Improving Service', PH, 1999.*
2. *Ballou, M., 'Business logistics / Supply chain management', Pearson Education, 2003.*
3. *Vollmann, T.E., 'Manufacturing Planning and Control for Supply Chain Management', 5e, McGraw Hill, 2005.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG333	MARKETING MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objective

To educate the students to apply concepts and techniques in marketing so that they become acquainted with the duties of a marketing manager with an emphasis to make the students exposed to the development, evaluation, and implementation of marketing management in a variety of business environments.

Course Outcomes

On successful completion of the Course students will be able to:

CO1: Illustrate key marketing concepts, theories and techniques for analysing a variety of marketing situations
CO2: Identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken and appreciate the implication for marketing strategy determination and implementation
CO3: Develop the ability to carry out a research project that explores marketing planning and strategies for a specific marketing situation
CO4: Understand the need and importance of sales promotions and make use of advertising
CO5: Manage a new product development process from concept to commercialization.
CO6: Illustrate the importance of modern trends in retailing and marketing logistics

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3	1								1			
CO2		1	3	3		2	1			2	2	2			
CO3	1	1	1	3	2	2	2		2	2	2	3			
CO4			2	2		2	1	1		3	3	3			
CO5	1	1	3	2		1	1			1	2	3			
CO6	1	1	3	2		1	1			1	2	3			

Syllabus Unit

1
Marketing Process: Definition, Marketing process, dynamics, needs, wants and demands, value and satisfaction, marketing concepts, environment, mix. Philosophies, selling versus marketing, organizations, industrial versus consumer marketing, consumer goods, industrial goods, product hierarchy.

Buying Behaviour and Market Segmentation: Major factors influencing buying behaviour, buying decision process, businessbuyingbehaviour. Segmenting consumer and business markets, market targeting.

UNIT 2
Product Pricing and Marketing Research: Objectives, pricing, decisions and pricing methods, pricing management. Introduction, uses, process of marketing research.

UNIT 3
Developing New Products - Challenges in new-product Development - Effective organizational arrangements - Managing the development Process: ideas - Concept to strategy - Development to commercialization – The consumer- adoption process. Advertising Sales Promotion and Distribution: Characteristics, impact, goals, types, and sales promotions- point of

purchase- unique selling proposition. Characteristics, wholesaling, retailing, channel design, logistics, and moderntrends in retailing.

TEXT BOOKS

1. *Kolter, P.,'Marketing Management', Pearson Education 2001.*
2. *Ramasamy and Namakumari, 'Marketing Environment: Planning, implementation and control the Indian context', 1990.*

REFERENCE BOOKS

1. *Paul, G.E. and Tull, D., 'Research for marketing decisions', Prentice Hall of India, 1975.*
2. *Tull, D.S. and Hawkins, 'Marketing Research', Prentice Hall of Inida-1997.*
3. *Kotler, P. and Armstrong, G., 'Principles of Marketing' Prentice Hall of India, 2000.*
4. *Skinner, S.J., 'Marketing', All India Publishers and Distributes Ltd. 1998.*
5. *Govindarajan, M., 'Industrial marketing management', Vikas Publishing Pvt. Ltd, 2003.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG334	PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To discuss the project life cycle and build a successful project from pre-implementation to completion.
- To introduce different project management tools and techniques

Course Outcomes

CO1: Appraise the selection and initiation of individual projects and its portfolios in an enterprise.
CO2: Analyze the project planning activities that will predict project costs, time schedule, and quality.
CO3: Develop processes for successful resource allocation, communication, and risk management.
CO4: Evaluate effective project execution and control techniques that results in successful project completion

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1				2		3	1	2	3	2
CO2	2	3	3	2	2				3		3	2	2	3	3
CO3	1	2	3	2	2				2		3	2	1	2	3
CO4	1	1	2		1				2		3	1	1	1	2

SyllabusUnit

1
Overview of Project Management: Verities of project, Project Features, Project Life Cycle – S-Curve, J-C **Project Selection:** Project Identification and Screening – New ideas, Vision, Long-term objectives, SWOT Analysis (Strength, Weakness, Opportunities, Threats).
Project Appraisal – Market Appraisal, Technical Appraisal, Economic Appraisal, Ecological Appraisal, and Financial Appraisal – Payback, Net Present Value (NPV), Internal Rate of Returns (IRR).
Project Selection – Decision Matrix, Technique for Order Preference using Similarity to Ideal Solution (TOPSIS), Simple Additive Weighting (SAW).

Unit 2
Project Presentation: WBS, Project Network – Activity on Arrow (A-O-A), Activity on Node (A-O-N).**Project Scheduling:** Gant Chart, Critical Path Method (CPM), Project Evaluation & Review Technique (PERT).**(6hrs)**
Linear time cost trade-offs in project - Direct cost, indirect cost, Project crashingResource Consideration - Profiling, Allocation, Levelling.
Introduction to project management software: Primavera/ Microsoft project

Unit 3
Project Execution: Monitoring control cycle, Earned Value Analysis (EVA), Project Control – Physical control, Human control, financial control.
Organizational and Behavioral Issues: Organizational Structure, Selection-Project Manager, Leadership Motivation, Communication, Risk Management.
Project Termination: Extinction, Addition, Integration, Starvation.

TEXT BOOKS

1. *Jack R. Meredith and Samuel J. Mantel, Jr. - 'Project Management- A Managerial Approach' Eighth Edition - John Wiley & Sons Inc - 2012.*
2. *Arun Kanda – 'Project Management-A Life Cycle Approach' PHI Learning Private Limited - 2011*

REFERENCE BOOKS

1. *'A Guide to Project Management Body of Knowledge' PMBOK GUIDE, Sixth edition, Project management Institute – 2017*
2. *Ted Klastrorin* **-** *'Project Management, Tools, and Trade-Offs'* **-** *John Wiley – 2011*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MNG335	ENTERPRISE MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- To impart knowledge on the fundamentals of costing, pricing methods and strategies.
- To give an overview of production operations planning.
- To summarize various quantitative methods of plant location, layout and lean manufacturing.
- To familiarize the concepts of e-commerce, e-purchasing, MRP and ERP in business

Course Outcomes

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

CO1: Understand the concepts of cost and pricing of goods and appraise project proposals
CO2: Design and analyze manufacturing and service processes and to measure the work performed.
CO3: Understand and analyze the key issues of supply chain Management
CO4: Understand the application of lean manufacturing tools and six sigma concepts
CO5: Select appropriate plant location and their layout methods
CO6: Create capacity plan, aggregate plan, schedule, ERP & MRP systems

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1							2	2			
CO2	2	1								1		2	1		1
CO3	2	1										2	1		1
CO4	2	1	1	1						1		2	1		1
CO5	2	1		1								2			
CO6	2	2	1	1							1	2	1		1

Syllabus Unit

1

Engineering Economics: cost concepts - types of costs - cost functions. Cost controls: reduction – tools & applications.Pricing policies – methods – problems.Process design and improvement – process capacity – process layout – process reengineering – job design. Work standards – work measurement – work sampling – problems.

Unit 2

Supply Chain Management – Basic Concepts, SC dynamics, push-pull boundary, integrated supply chain, logistics, customer relationship, supplier relationship – selection, rating and development, procurement, SC metrics and performance measurement - problems. Lean Manufacturing – concepts, wastes – tools viz., pull system, standardized work, takt time, kanban system, JIT, kaizen, SMED, 5S, value stream mapping, benefits of lean and implementationissues. Introduction to Six Sigma. Plant Location – globalization, factors affecting location decisions, facility location- Break-even method, rectilinear, factor-rating and centre of gravity – problems. Plant Layout – types, process layout,product layout, Systematic layout planning (SLP), Line Balancing problems. Capacity Planning – Aggregate Planning – importance, planning process, methods – problems.

Unit 3

Role of IT in business performance improvement – e-commerce – e-purchasing –Master Production Schedule, inventory lot sizing strategies, MRP basics – MRP explosion, Available to Promise(ATP) inventory – MRP calculations – MRP II – Scheduling – Gantt chart – Introduction to ERP – ERP software – ERP modules – ERP implementation.

TEXT BOOKS

1. *L J Krajewski, L.P.RitzmanMalhotra.M and Samir K. Srivastava, 'Operations Management: Processes and Value chains, 11e, Pearson, 2015.*
2. *R L Varshney& K L. Maheshwari, 'Managerial Economics', S Chand & Sons, 22e, 2014.*

REFERENCE BOOKS

1. *Richard B. Chase, Ravi Shankar, F. Robert Jacobs, 'Operations and Supply Chain Management' McGraw Hill Education (India) Private Limited.14e, 2017.*
2. *E S Buffa and R K Sariss, 'Modern Production/Operations Management', Wiley India Private Limited, 8e, 2007.*
3. *Harrison.B, Smith.C., and Davis.B.,, 'Introductory Economics', 2e Pr Macmillan, 2013.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports.

23MNG336	OPERATIONS RESEARCH	L-T-P-C: 3-0-0-3

Course Objectives

Familiarizing the students with quantitative tools and techniques, which are frequently applied in operational decisions

Course Outcomes

CO1: Formulate operations research models to optimize resources.
CO2: Solve transportation and assignment problems using suitable techniques.
CO3: Apply appropriate technique to analyze a project with an objective to optimize resources.
CO4: Solve operational problems using decision theory approaches.
CO5: Select suitable inventory model for effective utilisation of resources.
CO6: Solve Operations Research problems using software package

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2						2	2	2		
CO2	3	2	2		2						2	2	2		
CO3	3	2	2		2						2	2	2		
CO4	3	2	2		2						2	2	2		
CO5	3	2	2		2						2	2	2		
CO6	3	2	2		2						2	2	2		

SyllabusUnit1
Linear Programming: Formulations - graphical solutions - Simplex Method - Duality, Dual simplex method.
Transportation model: Assignment model – Travelling Salesman Problem.

Unit 2
Decision Theory: Decision Trees. Game theory - 2 person zero sum; mixed strategies; 2 x n and m x 2 games. Network Models- Project Networks- CPM / PERT- Project Scheduling – crashing networks and cost considerations-Resource leveling and smoothing - shortest route problem, minimal spanning tree problem, maximal flow problem.

Unit 3
Sequencing model – 2 machines ‘n’ jobs, ‘m’ machines ‘n’ jobs – n jobs 2 machines.
Inventory models: deterministic & probabilistic models. Quantity discounts. Selective Inventory Management Queuing models: Poisson arrival and exponential service times. Single server, multi-server. Queues -infinite and finite capacity queues.
Simulation –Monte Carlo simulation: simple problems

Lab session: Practicing case problems with excel solver/MatLab/LINGO package

TEXT BOOK
Hillier, F .S. and Lieberman, G .J, ‘Operations Research’, 9e, McGraw Hill, 2010

REFERENCE BOOKS

1. *Taha,H.A., ‘Operations Research: an Introduction’, 8e, Prentice HalI, New Delhi, 2008.*
2. *Ravindran, A., Phillips, D.J., and Solberg, J.J., ‘Operations Research- Principles and Practice’, John Wiley & Sons, 2005.*
3. *Wagner, H.M., ‘Principles of Operations Research’, Prentice Hall, New Delhi, 1998.*

4. *Hardley, G.,'Linear Programming', Narosa Book Distributors Private Ltd 2002.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	10	
Periodical 2	10	
*Continuous Assessment (Theory) (CAT)	15	
*Continuous Assessment(Lab) (CAL)	30	
End Semester		35

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE321	INDUSTRIAL ENGINEERING	L-T-P-C: 3-0-0-3

Course Objectives

- To inculcate the concepts of work study and its application to industrial practice
- Impart skills to design, develop, implement, and improve manufacturing/service systems

Course Outcomes

At the end of the course, the student will be able to

CO1: Create value to organizations through the analysis, evaluation, and improvement of work systems using work study and method study
CO2: Develop work systems through motion economy principles
CO3: Apply work measurement techniques to improve productivity, fix wages and incentives
CO4: Apply systematic layout planning techniques and work station design principles based on ergonomics and material handling.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1						1		3	2		
CO2	2	1	2	1	1					1		3	2		
CO3	1	2		1	1						1	3	2		
CO4	2	2		1	2						2	3	2		

SyllabusUnit

1
Work System: Elements of work, maintenance of machines, interaction, effect of working conditions and environment, physical and mental fatigue.
Productivity: Productivity, factors affecting production, Measurement of productivity.
Work Study: Definition and scope of work study; Areas of application of work study in industry; Human aspects ofwork study.
Method Study: Information collection, recording techniques, and processing aids; critical examination; development, installation and maintenance of improved methods.

Unit 2
Motion Economy and Analysis: Principles of motion economy; Motion analysis; Micromotion and Memomotion study; Therbligs and SIMO charts; Normal work area and design of work places; Basic parameters and principles ofwork design.
Work Measurement: Work measurement techniques; Calculation of standard time, work sampling and predetermined Motion time systems.
Wages and Incentive Schemes: Introduction, wage payment of direct and indirect labour, wage payment plans and incentives, various incentive plans, incentives for indirect labour

Unit 3
Plant Layout: Concept of plant layout, types of layout; factors affecting plant layout.
Ergonomics: Ergonomic Design of equipment and work place. work station design, factors considered in designing awork station, ergonomic design standards - Study of development of stress in human body and their consequences. Case Studies.Production planning and scheduling.
Material Handling: Introduction and functions of material handling equipment, selection of material handling equipment for different requirements, safety requirements.

Recent advances in Industrial Engineering.

TEXT BOOKS

1. *Barnes, R, "Motion and Time Study"* **-** *Design and Measurement of Work . NY: John Wiley and Sons, 8th Edition, 1985.*
2. *"Introduction to Work Study", 4ed, International Labor Office, Geneva, 2006.*

REFERENCE BOOKS

1. *Martand T. Telsang, 'Industrial Engineering and Production Management' S Chand; 2nd Rev Edn 2006.*
2. *Mahajan M., "Industrial Engineering and Production Management" Dhanpat rai and Sons Publishers, 2005.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continues Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE323	MANAGERIAL STATISTICS	L-T-P-C: 3-0-0-3

Course Objective

To impart the knowledge of basic statistical tools for analysis and interpretation of qualitative and quantitativedata for decision making

Course Outcomes

CO1: Apply basic probability and statistics concepts for various business problems
CO2: Perform test of hypothesis
CO3: Compute and interpret the result of regression and correlation analysis for forecasting
CO4: Solve real time problems by applying different decision making methods.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		2	2						2	2	3		
CO2	3	3		2	2						2	2	3		
CO3	3	3		2	2						2	2	3		
CO4	3	3		2	2						2	2	3		

Syllabus Unit

1
Quantitative methods: Basic terminology in probability, probability rules, conditions of statistical dependence and independence, Bayes Theorem, Discrete Random Variables review of probability distributions, measure of central tendency.
Sampling and sampling distributions: Introduction to sampling, random sampling, design of experiments, introduction to sampling distributions
Estimation: point estimates, interval estimates and confidence intervals, calculating interval estimates of mean from large samples, using t test, sample size estimation**.**

Unit 2
Testing hypothesis: Introduction, basic concepts, testing hypothesis, testing when population standard deviation isknown and not known, two sample tests.
Chi-square and analysis of variance: introduction, goodness of fit, analysis of variance, inferences about a population variation

Unit 3
Regression and correlation: Estimation using regression line, correlation analysis, finding multiple regression equation, modelling techniques,
Non parametric methods and time series and forecasting: Sign test for paired data, rank sum test, rank correlation, Kolmogrov – smirnov test, variations in time series, trend analysis, cyclic variation, seasonal variation and irregular variation. Decision theory**:** Decision tree analysis

TEXT BOOKS

1. *Levin R. I. and Rubin D. S. - 'Statistics for management' - Pearson Education – 2007 - 5th Edition*
2. *Montgomery D. C. and Runger G. C. - 'Applied Statistics and Probability for Engineers' - John Wiley & Sons - 2002 - 3rd Edition*

REFERENCE BOOKS

1. *Bain.L. J. and Engelhardt M. - 'Introduction to Probability and Mathematical Statistics' - Duxbury Press -*

March 2000 - 2nd Edition

2. *Hinkelmann K. and Kempthorne O. - 'Design and Analysis of Experiments : Volume I' - John Wiley & Sons, Inc. - December 2007 - 2nd Edition*
3. *Johnson R. A. and Wichern D. W. - 'Applied Multivariate Statistical Analysis' - Prentice-Hall, Inc. - December 2001 - 5th Edition*
4. *Myers R. H. - 'Classical and Modern Regression with Applications' - PWS-Kent Publishing Company - March 2000 - 2nd Edition*
5. *Devore J. L. - 'Probability and Statistics for Engineering and the Sciences' - Brooks/Cole Publishing Company - December 1999 - 5th Edition*
6. *Freund J. E. and Walpole R. E. - 'Mathematical Statistics' - Prentice-Hall Inc. - October 1986 - 4th Edition*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE323	TOTAL QUALITY MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objective

To impart knowledge on quality management principles, tools, techniques and quality standards for real lifeapplications

Course Outcomes

CO1: Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.
CO2: Evaluate the performance measures using various quality and management tools
CO3: Apply the Quality Function Deployment, Taguchi principles, Total Productive Maintenance and Failure Mode and Effect Analysis concepts to solve industrial problems.
CO4: Practice the various quality system in industry.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2										2	2		
CO2	1	2										2	2		
CO3	2	2	2									2	2		
CO4	2	2	2	2								2	2		

Syllabus Unit

1
Definition of quality - dimensions of quality. Quality planning - quality costs. Total Quality Management: historical review and principles –leadership - quality council - quality statements - strategic planning - Deming philosophy.Barriers to TQM implementation

Unit 2
Customer satisfaction – Customer retention - Employee involvement - Performance appraisal - Continuous process improvement - Supplier partnership - Performance measures. Seven tools of quality.Statistical fundamentals - Control Charts for variables and attributes - Process capability - Concept of six sigma - New seven management tools - Benchmarking**.**

Unit 3
Quality function deployment (QFD) - Taguchi quality loss function - Total Productive Maintenance (TPM) - FMEA.Need for quality systems - ISO 9000:2000 – Elements of quality systems (such as ISO 9000:2000). Implementation of quality system – documentation - quality auditing - QS 9000-ISO 14000

TEXT BOOK
Besterfiled D. H. **-** *'Total Quality Management'* **-** *Pearson Education Asia – 2015-4th Edition*

REFERENCE BOOKS

1. *Evans J. R, and Lidsay W. M.* **-** *'The Management and Control of Quality'* **-** *Southwestern (Thomson Learning)* **-** *2002* **-** *5th Edition*
2. *Feigenbaum A. V.* **-** *'Total Quality Management* **-** *Vol I &II ' – McGraw Hill* **-** *1991*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23MEE324	LEAN MANUFACTURING	L-T-P-C: 3-0-0-3

Course Objectives

- Understand Lean manufacturing principles and tools
- Inculcate the concepts of value stream mapping
- Familiarize lean implementation practices

Course Outcomes

CO1: Identify key requirements and concepts in lean manufacturing.
CO2: Initiate a continuous improvement change program in a manufacturing organization**CO3:** Analyze and improve a manufacturing system by applying lean manufacturing tools**CO4:** Build value stream map for improving the productivity
CO5: Improve productivity through lean practices

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											2	2		
CO2	2	2	2	1					2	1		1	2		1
CO3	2	2	2	2	1				2	1		1	2	1	2
CO4	2	2	2	1	1	1	1			1		2	2	1	1
CO5	2	2	2	1	1	1	1			1		2	2	1	1

SyllabusUnit

1
Introduction to Lean and Factory Simulation: History of Lean and comparison to other methods - The 7 Wastes, their causes and the effects - An overview of Lean Principles / concepts / tools - Stockless Production.
The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow –5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems.
Ford production systems – FPS gear model

Unit 2
Value Stream Mapping – Current state: Preparation for building a Current State Value Stream Map – Building a Current State Map (principles, concepts, loops, and methodology) – Application to the factory Simulation scenario.

Unit 3
Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completedFuture State Maps – Application to factory simulation
Implementation of lean practices - Best Practices in Lean Manufacturing.

TEXT BOOKS

1. *Womack, J.P., Jones, D.T., and Roos, D.,'The Machine that Changed the World', Simon & Schuster, New York, 2007.*
2. *Liker, J.K., 'Becoming Lean', Industrial Engineering and Management Press, 1997.*

REFERENCES BOOKS

1. *Womack, J.P. and Jones, D.T.,'Lean thinking', Simon & Schuster, USA, 2003.*
2. *Rother, M. and Shook, J., 'Learning to see', The Lean Enterprise Institute, Brookline, USA, 2003.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1	15	
Periodical 2	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignments, Projects, and Reports

23CSE321	SOFTWARE PROJECT MANAGEMENT	L-T-P-C: 3-0-0-3

Course Objectives

- This course describes the key aspects of a software project.
- It introduces the basic principles of Engineering Software Projects. Most, if not all, students' complete projects as part of assignments in various courses undertaken. These projects range in size, subject and complexity but there are basic project essentials that need to be understood and practiced for successful team project outcomes.
- The course provides an understanding of the purpose, methods and benefits of process management by exposing the student to the concepts, practices, processes, tools and techniques used in process management for software development.

Course Outcomes

CO 1: To understand the basic concepts, terminologies and issues of software project management.
CO 2: To apply appropriate methods and models for the development of solutions.
CO 3: To analyze the cost-benefits of calculations so as to optimize the selection strategy**CO 4:**
To evaluate methods, models and technologies towards achieving project success**CO 5:** To
design and evaluate network planning models with criticality

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1								1		3	2
CO2	3	2	3						3	3		2	3	2
CO3	3	2	2	3	2	2	2	2	3	3	2	2	3	2
CO4	2	2	2	1	3	2	2	2	3	3		2	3	2
CO5	3	2	3	3	3	2	2	2	3	3		2	3	2

SyllabusUnit

1
Introduction to Software Project Management- Software Projects - ways of categorizing software projects – problems with software projects - Project Life Cycle– Management -Setting objectives –Stakeholders - Project Team- Step-wise
: An overview of project planning -project Evaluation –Selection Of Appropriate Project Objectives- Software Effort Estimation Techniques, Function Point Analysis-Object Point-COCOMO.

Unit 2
Activity planning-- project schedules - sequencing and scheduling projects - Network planning model – AON andAOA-identifying critical activities-Crashing And Fast Tracking-,Risk management—Categories , Risk planning, Management and Control - Evaluating risks to the schedule. PERT- Resource Allocation, Monitoring and Tracking -Monitoring and control - allocation - identifying resource requirements - scheduling resources - creating critical paths
- publishing schedule - cost schedules- sequence schedule.

Unit 3
Monitoring and control – Visualizing Progress, Earned value analysis, managing people and organizing teams-organizational structures- Planning for small projects. Case Study: PMBOK , Agile Development

TEXT BOOK(S)
Mike Cotterell, Bob Hughes. Software Project Management, Fifth Edition, Tata McGraw-Hill; 2012.

REFERENCE(S)

1. *Roger S. Pressman. Software Engineering – A Practioner's Approach, Eighth Edition, Tata McGraw-Hill publishers; 2014.*
2. *Jalote P. Software Project Management in practice, Second edition, Person Education; 2003.*

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE322	FINANCIAL ENGINEERING	L-T-P-C: 3-0-0-3

Pre-Requisite(s): 19MAT112 Linear Algebra, 19MAT205 Probability and Random Processes

Course Objectives

- This course serves as an introduction to financial engineering including cash flows, financial decision making etc
- It gives a thorough yet highly accessible mathematical coverage of standard and recent topics of introductory investments: fixed-income securities, modern portfolio theory, optimal portfolio growth and valuation of multi-period risky investments.

Course Outcomes

CO1: Apply basic concepts to understand and evaluate cash flows
CO2: Evaluate and arrive at a financial investment decision employing the underlying knowledge of stocks and derivatives
CO3: Analyse and design Portfolio selection methods
CO4: Understand capital market theory for stock performance evaluation

CO-PO Mapping

PO/ PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			2								3	2
CO2	2	3	1										3	2
CO3	1	3			2								3	2
CO4	2	1											3	2

Syllabus Unit

1
Cash Flows and Fixed income securities: Investments and markets - Principal and interest - Present and future valuesof streams - IRR. Fixed income securities - Market value for future cash - Bond value - Bond details – Yields – Convexity – Duration - Immunization. Bond portfolio management - Level of market interest rates, Term structureof interest-rate theories.

Unit 2
Stocks and Derivatives: Common stock valuation - Present value of cash dividends - Earnings approach - Value versus price - Efficient markets theory - Technical analysis. Analysis of financial statements. Derivatives - futures and options - Black Scholes formula - Utility functions - Applications in financial decision making.

Unit 3
Portfolio analysis and capital market theory: Covariance of returns – Correlation - Portfolio return - Portfolio standard deviation - Two asset case - Efficient frontier - Optimum portfolio. Capital market theory - Capital market line - Sample diversifications to reduce risk - Characteristic line - Capital asset pricing model. Arbitrage price theory - Stock performance evaluation.

TEXT BOOK(S)

1. *David Luenberger, Investment Science. Second Edition, Oxford University Press; 2013*
2. *Jack Clark Francis, Richard W. Taylor. Investments, Schaum's Outlines, Tata McGraw Hill ;2006.*

REFERENCE(S)

1. Lyuu YD. Financial Engineering and Computation. Cambridge University Press; 2004.
2. Perry H. Beaumont. Financial Engineering Principles. John Wiley and Sons Inc, New Jersey; 2004.

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE323	ENGINEERING ECONOMIC ANALYSIS	L-T-P-C: 3-0-0-3

Course Objectives

- Prepare engineering students to analyze and understand the business, impact of economic environment on business decisions

Course Outcomes

CO1: Understand and evaluate the economic theories, cost concepts and pricing policies and draw inferences for the investment decisions for appraisal and profitability
CO2: Appraise the dynamics of the market and market structures and portray implication for profit and revenue maximization
CO3: Employ operations research and allied techniques in managerial economics for an enhanced analysis and decision making

CO-PO Mapping

PO/ PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2		2		2			3	2	3	2
CO2	1	3	2	1		2		2			3	2	3	2
CO3	2	3	2	2		2		2			3	2	3	2

SyllabusUnit

1
Economics: Nature and scope of managerial economics. Economic theory and managerial economics, Cost Concepts: Types of costs - Cost functions. Cost controls: reduction – Tools & Areas. Pricing policies- methods. Capital budgeting - cost of capital. Appraising project profitability

Unit 2
The essentials of demand and supply: The law of demand. Market demand curve. Other determinants of market demand. The law of supply. Determinants of market supply. The market mechanism. Price elasticity of demand, Profit and revenue maximization: Optimal input combination. Total revenue maximization.

Unit 3
Market structure: Perfect competition and monopoly. Characteristics of monopolistic competition. Oligopoly Operations Research techniques in managerial economics: Inventory models. Theory of games. Decision theory, Risk and Uncertainty, Measuring risk, Consumer behavior and risk aversion, Decision making under uncertainty with complete ignorance

TEXT BOOK(S)
Webster, T.J. Managerial Economics- Theory and Practice, Elsevier; 2004.

REFERENCE(S)
1. *Panneerselvam, R. Engineering Economics, Second Edition, PHI; 2013.*
2. *R L Varshney,K L. Maheshwari. Managerial Economics, S Chand & Sons;2014.*
3. *Harrison.B, Smith.C., and Davis.B. Introductory Economics, Second Edition, Pr Macmillan; 2013.*

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CSE324	INFORMATION SYSTEMS	L-T-P-C: 3-0-0-3

Course Objectives

- This course is to expose the students to the managerial issues relating to information systems and also understand the role of Business Process Reengineering technique in an organization.
- The course also focus on the management of information technology to provide efficiency and effectiveness or strategy decision making.

Course Outcomes

CO1: Understand the fundamental concepts of Information Systems in business.
CO2: Understand and analyse the strategic role played by Information Systems in e-commerce.
CO3: Analyse management challenges in Global Businesses predominantly dependent on IS functions.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	2
CO2	2	2			2								3	2
CO3	1	3			2	2					2	1	3	2

Syllabus Unit

1
Introduction to IS -Fundamental concepts-IS in Business- Role of IS –Information system and technologies – Components of IS –resources and acivities –Types of IS- E business Applications –Role of BI and Analytics in IS- Functional Business Systems - Marketing Systems, Manufacturing systems, Human Resource Systems, Accounting Systems and Financial Management Systems.-Cross-Functional Enterprise Systems Cross-Functional Enterprise Applications, Enterprise Application Integration, Transaction Processing Systems and Enterprise Collaboration Systems. Enterprice Business Systems CRM, ERP, SCM , Case Studies

Unit 2
Electronic Commerce Systems : Scope of e-Commerce, Essential e-Commerce Processes and Electronic Payment Processes - E-commerce Applications & Issues -Decision Support Systems- Business and Decision Support, Decision Support Trends, Management Information Systems, Online Analytical Processing, Decision Support Systems, Executive Information Systems, Enterprise Portals and Decision Support - Knowledge Management Systems. Artificial Intelligence Technologies and its application in Business- Strategic role of IT- Competing with IT, valuechain ,reengineering, virtual organization ,knowledge creation-Organizational Planning, The Scenario Approach, Planning for Competitive Advantage, SWOT Business Models and Planning, Business IT Planning, -Business/ IT Strategies and Business Application Planning- Developing and Implementing Business Systems - ImplementationChallenges- barriers - change management-: Case Studies

Unit 3
Management challenges-Security, Ethical and Societal Challenges- Ethical Responsibility of Business Professionals, Computer Crime, Privacy Issues, Health Issues, and Societal Solutions- Security Management of IT- Tools of security Management, Internetworked Security Defenses, other security measures –system controls and audits- Enterprise and Global Management of IT- Managing the IS Function and Failures in IT Management - Global IT Management, Cultural, Political and Geo-economic Challenges, Global Business/IT Strategies, Global Business/IT Applications,Global IT Platforms, Global Data Access Issues and Global Systems Development –Case studies

TEXT BOOK(S)

1. *O'Brien JA, Marakas GM. Management information systems. McGraw-Hill Irwin; 2006.*
2. *Brien,Marakas G M and Behi R , MIS,9th edition, Tata McGraw Hill Special Indian Edition;2010.*

REFERENCE(S)

Laudon K, Laudon JP. Management Information Systems;2010

Evaluation Pattern

Assessment	Internal	External
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMSCOMMON TO ALL PROGRAMS

23CUL230	ACHIEVING EXCELLENCE IN LIFE -AN INDIAN PERSPECTIVE	L-T-P-C: 2-0-0-2

Course Objectives:

The course offers to explore the seminal thoughts that influenced the Indian Mind on the study of human possibilitiesfor manifesting excellence in life. This course presents to the students, an opportunity to study the Indian perspective of Personality Enrichment through pragmatic approach of self analysis and application.

SyllabusUnit 1
Goals of Life – Purusharthas
What are Purusharthas (Dharma, Artha, Kama, Moksha); Their relevance to Personal life; Family life; Social life & Professional life; Followed by a Goal setting workshop;
Yogic way of Achieving Life Goals – (Stress Free & Focused Life)
Introduction to Yoga and main schools of Yoga; Yogic style of Life & Time Management (Work Shop);Experiencing life through its Various Stages
Ashrama Dharma; Attitude towards life through its various stages (Teachings of Amma);

Unit 2
Personality Development
What is Personality – Five Dimensions – Pancha Kosas (Physical / Energy / Mental / Intellectual / Bliss); Stress Management & Personality; Self Control & personality; Fundamental Indian Values & Personality;
Learning Skills (Teachings of Amma)
Art of Relaxed Learning; Art of Listening; Developing 'Shraddha' – a basic qualification for obtaining Knowledge; Communication Skills - An Indian Perspective;

Unit 3
Developing Positive Attitude & Friendliness - (Vedic Perspective);
Achieving Work Excellence (Karma Yoga by Swami Vivekananda & teachings based on Amma);
Leadership Qualities – (A few Indian Role models & Indian Philosophy of Leadership);

REFERENCE BOOKS:

1. *Awaken Children (Dialogues with Sri Mata Amritanandamayi) Volumes 1 to 9*
2. *Complete works of Swami Vivekananda (Volumes 1 to 9)*
3. *Mahabharata by M. N Dutt published by Parimal publications – New Delhi (Volumes 1 to 9)*
4. *Universal message of Bhagavad-Gita (An exposition of Gita in the light of modern thought and Modern needs) by Swami Ranganathananda. (Vols.1 to 3)*
5. *Message of Upanishads, by Swami Ranaganathananda published by Bharatiya Vidya Bhavan, Bombay.*
6. *Personality Development – Swami Vivekananda published by Advaitha Ashram, Kolkatta.*
7. *Art of Man Making - Swami Chinmayananda published by Chinmaya Mission, Bombay*
8. *Will Power and its Development- Swami Budhananda published by Advaitha Ashram, Kolkatta*
9. *Ultimate Success - Swami Ramakrishnananada Puri published by Mata Amritanandamayi Math, Kollam*
10. *Yoga In Daily Life - Swami Sivananda – published by Divine Life Society*
11. *Hindu Dharma - H. H. Sri Chandrasekharandra Saraswati published by Bharatiya Vidya Bhavan, Bombay*
12. *All about Hinduism – Swami Sivananda - Published by Divine Life Society*
13. *The Mind and its Control by Swami Budhananda published by Advaitha Ashram, Kolkatta*
14. *Krida Yoga - Vivekananda Kendra, Publication.*
15. *Valmiki Ramayana – Four volumes- published by Parimal Publications, Delhi*

16. *New perspectives in Stress Management - Dr H R Nagendra & Dr R Nagaratna published by Swami Vivekananda Yoga Prakashana, Bangalore.*
17. *Mind Sound Resonance Technique (MSRT) Published by Swami Vivekananda Yoga Prakashana, Bangalore.*
18. *Yoga & Memory - Dr H R Nagendra & Dr. Shirley Telles, published by Swami Vivekananda Yoga Prakashana, Bangalore.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL231	EXCELLENCE IN DAILY LIFE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

1. The anatomy of 'Excellence'. What is 'excellence'? Is it judged by external factors like wealth?
2. The Great Flaw. The subject-object relationship between individual and world. Promote subject enhance excellence.
3. To work towards excellence, one must know where he is. Our present state... An introspective analysis. Our faculties within.

Unit 2

4. The play of the mind. Emotions – convert weakness into strength.
5. The indispensible role of the intellect. How to achieve and apply clear thinking?
6. The quagmire of thought.The doctrine of Karma – Law of Deservance.
7. Increase Productivity, reduce stress.. work patterning.

Unit 3

8. The art of right contact with the world. assessment, expectations.
9. Myths and Realities on key issues like richness, wisdom, spirituality.
10. Collect yourself, there is no time to waste. The blue-print of perfect action.

REFERENCES:

The Bhaja Govindam and the Bhagavad Gita.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL232	EXPLORING SCIENCE AND TECHNOLOGY IN ANCIENT INDIA	L-T-P-C: 2-0-0-2

OBJECTIVES:

This course offers a journey of exploration through the early developments in India of astronomy, mathematics, technologies and perspectives of the physical world. With the help of many case studies, the students will be equipped to understand concepts as well as well as actual techniques.

SyllabusUnit 1

1. General introduction: principles followed and sources;
2. Astronomy & mathematics from the Neolithic to the Indus civilization;
3. Astronomy & mathematics in Vedic literature;
4. Vedanga Jyotisha and the first Indian calendars;
5. Shulba Sutras and the foundations of Indian geometry;

Unit 2

1. Astronomy & mathematics in Jain and Buddhist literature;
2. The transition to the Siddhantic period; Aryabhata and his time;
3. The Aryabhatiya: concepts, content, commentaries;
4. Brahmagupta and his advances;
5. Other great Siddhantic savants;
6. Bhaskara II and his advances;

Unit 3

1. The Kerala school of mathematics;
2. The Kerala school of astronomy;
3. Did Indian science die out?;
4. Overview of recent Indian scientists, from S. Ramanujan onward;
5. Conclusion: assessment and discussion;

TEXTBOOK:

Indian Mathematics and Astronomy: Some Landmarks, by S. Balachandra Rao

REFERENCE:

IFIH's interactive multimedia DVD on Science & Technology in Ancient India.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23CUL233	YOGA PSYCHOLOGY	L-T-P-C: 2-0-0-2

OBJECTIVES:

This course offers the foundation necessary to understand Eastern approaches to psychology and spirituality. Thecourse includes experiential components centering on meditation and spiritual practice.

SyllabusUnit 1
Introduction
Introduction to Modern Psychology
A short history of Modern Psychology - Major Schools of Modern Psychology - The three major forces in Western Psychology - Freudian Psychoanalysis; Behaviourism; Humanistic Psychology.

Introduction to Indian Psychology
What is Yoga? - Rise of Yoga Psychology tradition - Various schools of Yoga Psychology - Universal Goal of allYoga-schools.

Patanjali Yoga Sutra – 1
Introduction to Rishi Patanjali - Bird view of Yoga-Sutra - Definition of Yoga – Vrittis.

Patanjali Yoga Sutra – 2
Five Kinds of Vrittis - Pramanam - sources of right knowledge - Viparyayah – unfolded belief - Vikalpah – Unfoldedbelief - Smriti – Memory.

Unit 2
Patanjali Yoga Sutra – 3
Two formulae - Necessity of Abhyasah and Vairagyah - Foundation of Abhyasah - Foundation of Vairagyah.

Patanjali Yoga Sutra – 4
Introduction to Samadhi - Samprajnata-Samadhi - Reasoning in Samprajnata-Samadhi - Reflection in Samprajnata-Samadhi - Bliss in Samprajnata-Samadhi - Sense of Individuality in Samprajnata-Samadhi.

Patanjali Yoga Sutra – 5
Main obstacles in the path of Yoga - other obstructions - removal of obstacles by one – pointedness; by controlling Prana - by observing sense experience - by inner illumination - by detachment from matter - by knowledge of dream and sleep - by meditation as desired.

Patanjali Yoga Sutra – 6
How to make mind peaceful? - Cultivating opposite virtues: happiness – friendliness - misery – compassion - virtue – gladness - vice – indifference.

Patanjali Yoga Sutra – 7
Five causes of Pain - avidya – ignorance (Root Cause) - asmita – 'I-Feeling' – raga – attraction - dwesha – repulsion - abhinivesha – clinging to life.

Unit 3
Patanjali Yoga Sutra – 8
Necessity of Yoga practice - eight parts of Yoga practice - five Yamas: ahimsa – satya – asteya – brahmacharyam – aparigraha.

Patanjali Yoga Sutra – 9
Five Niyamas: Soucha – Santhosha – Tapas – Swadyah – Ishwara - Pranidhanam.

Patanjali Yoga Sutra – 10
Asanam – Pranayamah - various kinds of Pranayamah - Pratyaharah - Mastery over the senses.Report review Conclusion

REFERENCES:

1. *The course book will be "The four chapters of Freedom" written by Swami Satyananda Saraswati of Bihar School of Yoga, Munger, India.*
2. *"The message of Upanishads" written by Swami Ranganathananda. Published by Bharathiya Vidya Bhavan.*
3. *Eight Upanishads with the commentary of Sankaracharya, Translated by Swami Gambhirananda, Published by Advaita Ashram, Uttaranjal.*
4. *'Hatha Yoga Pradipika' Swami Muktibodhananda, Yoga Publications Trust, Munger, Bihar, India*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG230	BUSINESS COMMUNICATION	L-T-P-C: 1-0-3-2

OBJECTIVES:

To introduce business vocabulary; to introduce business style in writing and speaking; to expose students to thecross-cultural aspects in a globalised world; to introduce the students to the art of persuasion and negotiation inbusiness contexts.

Course Outcomes

CO1: Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in the professional context
CO2: Understand organizational structures, pay structures and performance assessments
CO3: Apply language skills in drafting various business documents and other necessary communications in the business context
CO4: Understand and address cross cultural differences in the corporate environment
CO5: Participate in planned and extempore enactments of various business situations

CO-PO Mapping

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

SyllabusUnit 1
Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles.

Unit 2
Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – Speaking:Conversational practice, telephonic conversations, addressing a gathering, conducting meetings.

Unit 3
Active Listening: Pronunciation – information gathering and reporting - Speaking: Cross-Cultural Issues, Group Dynamics, negotiation& persuasion techniques.

Activities
Case studies & role-plays.

BOOKS RECOMMENDED:

1. *Jones, Leo & Richard Alexander. New International Business English. CUP. 2003.*
2. *Horner, David & Peter Strutt. Words at Work. CUP. 1996.*
3. *Levi, Daniel. Group Dynamics for Teams. 3 ed. Sage Publications India Pvt. Ltd. New Delhi, 2011.*
4. *Owen, Roger. BBC Business English. BBC. 1996.*

5. *Henderson, Greta Lafollette & Price R Voiles. Business English Essentials. 7th Edition. Glencoe / McGraw Hill.*
6. *Sweeney, Simon. Communicating in Business. CUP. 2000.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG231	INDIAN THOUGHT THROUGH ENGLISH	L-T-P-C: 2-0-0-2

OBJECTIVES:

To expose the students to the greatness of Indian Thought in English; to develop a sense of appreciation for the lofty Indian Thought; to develop an understanding of the eclectic Indian psyche; to develop an understanding about thesocietal changes in the recent past.

SyllabusUnit 1

Poems
Rabindranath Tagore's Gitanjali (1-10); Nizzim Ezekiel's Enterprise; A.K. Ramanujam's Small-Scale Reflections on a Great House.

Unit 2Prose
Khushwant Singh's The Portrait of a Lady; Jhumpa Lahiri's Short Story - Interpreter of Maladies.

Unit 3

Drama and Speech
Vijay Tendulkar's Silence, the Court is in Session; Motivational speeches by Jawaharlal Nehru/ S. Radhakrishnan / A. P. J. Abdul Kalam's My Vision for India etc. (any speech).

REFERENCES:

1. *Lahiri, Jhumpa. Interpreter of Maladies, Harper Collins Publications, 2000.*
2. *Ramanujan A. K. ed. K. M. George, Modern Indian Literature: An Anthology, Vol. I, Sahitya Akademi, 1992.*
3. *Singh, Khushwant. The Portrait of a Lady: Collected Stories, Penguin, 2009.*
4. *Tagore, Rabindranath. Gitanjali, Penguin Books India Pvt. Ltd, 2011.*
5. *Tendulkar, Vijay. Five Plays, Oxford University Press, 1996.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG232	INSIGHTS INTO LIFE THROUGH ENGLISH LITERATURE	L-T-P-C: 2-0-0-2

OBJECTIVES:

To expose the students to different genres of Literature; to hone reading skills; to provide deeper critical and literaryinsights; to enhance creative thinking; to promote aesthetic sense.

SyllabusUnit 1

Poems
1. W. H. Auden: Refugee Blues; 2. A. K. Ramanujan: Obituary; 3. William Blake: The LittleBlack Boy; 4. Gieve Patel: Grandparents at a Family Get–together.

Unit 2

Short Stories
1. Chinua Achebe: Marriage is a Private Affair; 2. Ruskin Bond: The Thief; 3. Isai Tobolsky: Not Just Oranges; 4.K A Abbas: The Refugee

Unit 3Prose
1. A G Gardiner: On The Philosophy of Hats; 2. Robert Lynd: Mispronunciation

Practicals:

Role plays: The Proposal, Chekov / Remember Ceaser, Gordon Daviot / Final Solutions, Mahesh Dattani, Bookreviews, Movie reviews.

SUGGESTED READING:
The Old Man and the Sea, Hemingway / Any one of the novels of R.K. Narayan, etc.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG233	TECHNICAL COMMUNICATION	L-T-P-C: 2-0-0-2

OBJECTIVES:

To introduce the students to the elements of technical style; to introduce the basic elements of formal correspondence; to introduce technical paper writing skills and methods of documentation; to improve oral presentation skills in formal contexts.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Understand and use the basic elements of formal correspondence and methods of documentation
CO2: Learn to edit technical content for grammatical accuracy and appropriate tone and style
CO3: Use the library and internet recourses for research purposes
CO4: Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities

Mapping of course outcomes with program outcomes:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										3				
CO2										3				
CO3				1										
CO4									3	3				

Syllabus:

Unit 1
Mechanics of writing: Grammar rules – punctuation - spelling rules - tone and style - graphical Representation.

Unit 2
Different kinds of written documents: Definitions – descriptions – instructions – recommendations - manuals -reports – proposals; Formal Correspondence: Letter Writing including job applications with Resume.

Unit 3
Technical paper writing: Library research skills - documentation style - document editing – proof reading – formatting.

Practice in oral communication and Technical presentations

REFERENCES:

1. *Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk, William Jr. and White. E B. "The Elements of Style" New York. Alliyan & Bacon, 1999.*
4. *Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23ENG234	INDIAN SHORT STORIES IN ENGLISH	L-T-P-C: 2-0-0-2

OBJECTIVES:

To help the students learn the fine art of story writing; to help them learn the techniques of story telling; to helpthem study fiction relating it to the socio- cultural aspects of the age; to familiarize them with different strategies of reading short stories; to make them familiar with the morals and values held in high esteem by the ideals of Indianness.

SyllabusUnit 1
Introduction: Differences between novel and short stories – origin and development of short stories - Rabindranath Tagore: Kabuliwallah; Mulk Raj Anand: The Gold Watch.

Unit 2
R. K. Narayan: Sweets for Angels; K. A. Abbas: The Refugee; Khushwant Singh: The Mark of Vishnu.

Unit 3
Masti Venkatesha Iyengar: The Curds-Seller; Manohar Malgonkar: Upper Division Love; Romila Thapar: The Spell; Premchand: The Voice of God.

TEXT:
M. G. Narasimha Murthy (ed), Famous Indian Stories. Hyderabad: Orient Black Swan, 2014

REFERENCE:
Mohan Ramanan (Ed), English and the Indian Short Story: Essays in Criticism, Hyderabad, Orient Black Swan,2000.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23FRE230	PROFICIENCY IN FRENCH LANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

SyllabusUnit 1

Population - Identity
How to introduce yourself (name, age, address, profession, nationality); Numbers; How to ask questions; Grammar – Pronouns - subjects; Regular verbs of 1st group (er) in the present; Être (to be) and avoir (to have) inthe present; Interrogative sentence; Gender of adjectives.

Unit 2

The suburbs - At the train station
Introduce someone; Buy a train ticket or a cinema ticket; Ask for information; Official time; Ask for a price; Thecity (church, town hall, post office…)
Grammar – Pronouns - subjects (continuation); Gender of adjectives (continuation); Plural of nouns and adjectives; Definite and indefinite articles; Interrogative adjectives; I would like (Je voudrais).

Unit 3

Paris and the districts - Looking for a room
Locate a room and indicate the way; Make an appointment; Give a price; Ordinal numbers; Usual time; Ask for thetime.
Grammar - Imperative mode; Contracted articles (au, du, des); negation.

TEXTBOOK:
Metro St Michel **-** *Publisher: CLE international*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23FRE231	PROFICIENCY IN FRENCH LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

SyllabusUnit 1

The first room of a student
A party to celebrate the 1st room; Description of a room; furniture; Locate objects: prepositions (devant, derrière,dans…), Read advertisement; Appreciation (I like, I prefer,).

Grammar - Perfect past tense with avoir; Possessive adjectives (mon, ton, son…); Demonstrative adjectives (ce, cet, cette); Yes (oui, si).

Unit 2 Small jobs
Conversation on the phone; Give Time indications; Answer a job offer; Describe a job; Suggest a meeting time. Grammar - Perfect past tense with être and avoir (continuation); Possessive adjectives (notre, votre, leur); Prepositions (à, pour, avec …); Pronoun as direct object (le, la, l', les).

Unit 3

University Restaurant
Inquiry; Express an opinion; Ask questions (continuation); Food, meals, taste, preferences; Nutrition, diet, choosea menu or diet, Expression of quantities (beaucoup, peu).

Grammar - Partitif (expressing quantity) (du, de la, pas de….); Comparison (plus...que, moins….que, autant …que); Interrogation (continuation), inversion, Est-ce que, qu'est-ce que?.

TEXTBOOK:
Metro St Michel - Publisher: CLE International

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER230	GERMAN FOR BEGINNERS I	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Greetings; Introducing one-self (formal and informal context), saying their name, origin, living place, occupation. Numbers 1-100; Saying the telephone number. Countries and Languages.
Grammar: Structure – W - Questions and Yes/No questions and statements, personal pronouns, verb conjugations. Articles. Vocabulary: Professions.

Unit 2
Giving the personal details. Name, age, marital status, year of birth, place of birth, etc.Numbers till 1000. Saying a year. Alphabets – spelling a word.
Filling up an application form; In the restaurant – making an order.
Grammar: Definite, indefinite and negative article in nominative. Accusative: indefinite and negative Article Vocabulary: Food items

Unit 3
Numbers above 1000. Orientation in Shopping plazas: asking the price, where do I find what, saying the opinion.Grammar: Accusative – definite article. Adjectives and plural forms. Vocabulary: Furniture and currencies.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER231	GERMAN FOR BEGINNERS II	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Shopping and orientation in supermarket; Conversation between the customer and salesman; Where one finds what in supermarket; Asking for requests and suggestions.

Grammar: Dative of personal pronouns. Imperative form. Vocabulary: Consumables and measurements;

Unit 2
Appointments; Work and leisure time activities; Time, weekdays, months and seasons; saying the date; fixing upan appointment.

Grammar: Model verbs; Prepositions with time and place; Ordinal numbers. Vocabulary: Leisure activities, weekdays, months and seasons.

Unit 3
Family and household; Family and relations; household and daily routine. Grammar: Possessive articles; Divisibleand indivisible verbs.
Vocabulary: Family circle; Household articles.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER232	PROFICIENCY IN GERMANLANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

Syllabus

To have an elementary exposure to German language; specifically

1. to have some ability to understand simple spoken German, and to be able to speak it so as to be able to carry on life in Germany without much difficulty (to be able to do shopping, etc.);
2. to be able to understand simple texts, and simple forms of written communication;
3. to have a basic knowledge of German grammar;
4. to acquire a basic vocabulary of 500 words;
5. to be able to translate simple letters with the use of a dictionary; and
6. to have some familiarity with the German life and culture.

(This will not be covered as part of the regular classroom teaching; this is to be acquired by self-study.)Some

useful websites will be given.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23GER233	PROFICIENCY IN GERMAN LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

Syllabus

The basic vocabulary and grammar learned in the earlier course is mostly still passive knowledge. The endeavourof this course is to activate this knowledge and develop the skill of communication.

Topics are: Airport, railway station, travelling; shopping; invitations, meals, meeting people; around the house; the human body; colours; professions.

Past and future tenses will be introduced. Applying genitive, dative and accusative. Some German culture. Films.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HIN230	HINDI I	L-T-P-C: 2-0-0-2

OBJECTIVES:

To teach Hindi for effective communication in different spheres of life - Social context, Education, governance,Media, Business, Profession and Mass communication.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Gain knowledge about the nature and culture of Hindi language
CO2: Understand the structural aspects of Hindi language
CO3: Apply the knowledge of the grammatical structures to communicate in Hindi
CO4: Analyse the social significance of modern literature.
CO5: Develop the ability to translate a given text to Hindi

CO-PO Mapping:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									2	3				
CO2									2	3				
CO3									2	3				
CO4										3				
CO5									2					

SyllabusUnit 1
Introduction to Hindi Language, National Language, Official Language, link Language etc. Introduction to Hindi language, Devanagari script and Hindi alphabet.

Shabda Bhed, Roopanthar ki Drishti se- Bhasha – Paribhasha aur Bhed – Sangya - Paribhasha Aur Bhed - Sangyake Roopanthar - kriya.

Unit 2
Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb indifferent tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender& number - General vocabulary for conversations in given context –understanding proper pronunciation - Conversations, Interviews, Short speeches.

Unit 3
Poems – Kabir 1st 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

Unit 4
Letter writing – personal and Formal – Translation from English to Hindi.

Unit 5
Kahani – Premchand: Kafan, Abhilasha, Vidroh, Poos ki rath, Juloos.

BOOKS:

1. *Prem Chand Ki Srvashrestha Kahaniyam: Prem Chand; Diamond Pub Ltd. New Delhi*
2. *Vyavaharik Hindi Vyakaran ,Anuvad thaha Rachana : Dr. H. Parameswaran, Radhakrishna publishing House, New Delhi*
3. *Kamtha Prasad Guru : Hindi Vyakaran, Best Book pub House, New Delhi*
4. *Poetry : Kavya Ras - Ed: T.V. Basker - Pachouri Press; Mathura*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HIN231	HINDI II	L-T-P-C: 2-0-0-2

OBJECTIVES:

Appreciation and assimilation of Hindi Literature both drisya & shravya using the best specimens provided as anthology.

Course Outcomes:

After the completion of the course the student will be able to:

CO1: Understand the grammatical structures of Hindi CO2: Understand the post modern trends of literature CO3: Enhance critical thinking and writing skills
CO4: Identify and analyse different literary and audio-visual material
CO5: Apply fundamental knowledge of Hindi in formal and informal writing

CO-PO Mapping:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									**1**	**2**				
CO2									**1**	**2**				
CO3									**1**	**2**				
CO4										**3**				
CO5									**1**	**2**				

Syllabus:

Unit 1
Kavya Tarang; Dhumil ke Anthim Kavitha [Poet-Dhumil]; Dhabba [Poet-Kedarnath Singh]; Proxy [Poet-Venugopal]; Vakth [Poet-Arun Kamal]; Maachis [Poet-Suneeta Jain].

Unit 2
Communicative Hindi - Moukhik Abhivyakthi

Unit 3
Audio-Visual Media in Hindi – Movies like Tare Zameen par, Paa, Black etc., appreciation and evaluation. Newsreading and presentations in Radio and TV channels in Hindi.

Unit 4
Gadya Manjusha – Budhapa, Kheesa, Sadachar ka Thavis

Unit 5
Translation: Theory and Practice - Letter writing: Formal and Personal – Introduction to Hindi Software.

BOOKS:

1. *Kavay Tarang: Dr. Niranjan, Jawahar Pusthakalay, Mathura.*

2. *Gadya Manjusha: Editor: Govind, Jawahar Pusthakalay, Mathura*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM230	EMOTIONAL INTELLIGENCE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Emotional Intelligence: Concept of Emotional Intelligence, Understanding the history and origin of Emotional Intelligence, Contributors to Emotional Intelligence, Science of Emotional Intelligence, EQ and IQ, Scope of Emotional Intelligence.

Unit 2
Components of Emotional Intelligence: Self-awareness, Self-regulation, Motivation, Empathy, Social skills. Emotional Intelligence Competencies, Elements of Emotional Intelligence, Models of Emotional Intelligence: The Ability-based Model, The Trait Model of Emotional Intelligence, Mixed Models of Emotional Intelligence.

Unit 3
Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place? Cost–savings of Emotional Intelligence, Emotionally Intelligent Leaders, Case Studies Measuring Emotional Intelligence: Emotionally Intelligence Tests, Research on Emotional Intelligence, Developing Emotional Intelligence.

REFERENCES:

1. *Daniel Goleman (1996). Emotional Intelligence- Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group*
2. *Daniel Goleman (2000). Working with Emotional Intelligence. Bantam Doubleday Dell Publishing Group*
3. *Liz Wilson, Stephen Neale & Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan Page India Private Limited*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM231	GLIMPSES INTO THE INDAN MIND -THE GROWTH OF MODERN INDIA	L-T-P-C: 2-0-0-2

Syllabus Unit 1
Introduction
General Introduction; ‘His + Story’ or ‘History’ ?; The concepts of ‘nation’, ‘national identity’ and ‘nationalism’;Texts and Textualities: Comparative Perspectives.

Unit 2
Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:
Raja Ram Mohan Roy; Dayananda Saraswati; Bal Gangadhar Tilak; Rabindranath Tagore;

Unit 3
Selected writings / selections from the complete works of the following authors will be taken up for study in a chronological order:
Swami Vivekananda; Sri Aurobindo; Ananda K. Coomaraswamy; Sister Nivedita; Mahatma Gandhi; JawaharlalNehru; B.R. Ambedkar; Sri Chandrasekharendra Saraswati, the Paramacharya of Kanchi; Dharampal; Raja Rao; V.S. Naipaul.

Conclusion.

REFERENCES:

1. *Tilak, Bal Gangadhar. The Orion / Arctic Home in the Vedas.*
2. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
3. *Vivekananda, Swami. “Address at the Parliament of Religions”/“The Future of India”/“In Defence of Hinduism” from Selections from the Complete Works of Swami Vivekananda.*
4. *Aurobindo, Sri. The Renaissance in India / On Nationalism.*
5. *Coomaraswamy, Ananda K. Essays in Indian Idealism (any one essay) / Dance of Shiva.*
6. *Nivedita, Sister. “Noblesse Oblige: A Study of Indian Caste” / “The Eastern Mother” from The Web of Indian Life.*
7. *Gandhi, Mahatma. Hind Swaraj.*
8. *Nehru, Jawaharlal. “The Quest” from Discovery of India.*
9. *Ambedkar, B. R. “Buddha and His Dhamma” from Collected Works.*
10. *Saraswati, Chandrasekharendra. “The Sastras and Modern Life” from The Hindu Dharma.*
11. *Dharampal. Bharatiya Chitta, Manas and Kala / Understanding Gandhi.*
12. *Naipaul, V. S. India: A Wounded Civilization / India: A Million Mutinies Now.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM232	GLIMPSES OF ETERNAL INDIA	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction

A peep into India's glorious past

Ancient India – the vedas, the vedic society and the Sanatana Dharma – rajamandala and the Cakravartins – Ramarajya – Yudhisthira's ramarajya; Sarasvati - Sindhu Civilization and the myth of the Aryan Invasion; Classical India – Dharma as the bedrock of Indian society – Vaidika Brahmanya Dharma and the rise of Jainism and Buddhism – the sixteen Mahajanapadas and the beginning of Magadhan paramountcy - Kautilya and his Arthasastra – Chandragupta Maurya and the rise of the Mauryan empire – Gupta dynasty Indian art and architecture – classicalsanskrit literature – Harsavardhana; Trade and commerce in classical and medieval India and the story of Indiansupremacy in the Indian ocean region; The coming of Islam – dismantling of the traditional Indian polity – the Mughal empire – Vijayanagara samrajya and days of Maratha supremacy.

Unit 2

India's contribution to the world: spirituality, philosophy and sciences

Indian Philosophy – the orthodox (Vaidika) and the heterodox (atheistic) schools; Ramayana and Mahabharata; Bhagavad Gita; Saints and sages of India; Ancient Indian medicine: towards an unbiased perspective; Ancient Indian mathematics; Ancient Indian astronomy; Ancient Indian science and technology.

The arrival of Europeans, British paramountcy and colonization

What attracted the rest of the world to India?; India on the eve of the arrival of European merchants; The story of colonization and the havoc it wrecked on Indian culture and civilization; Macaulay and the start of the distortion ofIndian education and history; Indian economy – before and after colonization: a brief survey; The emergence ofmodern India.

Unit 3

Women in Indian society

The role and position of women in Hindu civilization; Gleanings from the Vedas, Brihadarnyaka Upanishad, Saptasati Devi Mahatmyam, Ramayana, Mahabharata, Manusmriti, Kautilya's Arthasastra and Mrichchhakatikamof Sudraka; The role and position of Indian women vis-a-vis Islam and European cultures; The great women of India.

Modern India

The national movement for freedom and social emancipation; Swami Vivekananda, Sri Aurobindo, RabindranathTagore; Understanding Mahatma Gandhi; A new nation is born as a republic – the pangs of birth and growth; India since Independence – the saga of socio-political movements; Problems facing the nation today; Globalization and Indian Economy; Bharatavarsha today and the way ahead: Regeneration of Indian National Resources.

Conclusion

The Wonder that was India; The 'politics' and 'purpose' of studying India.

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1. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
2. *Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
3. *Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
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6. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
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11. *Mahadevan, T. M. P. Invitations to Indian Philosophy. Madras: University of Madras.*
12. *Hiriyanna, M. Outlines of Indian Philosophy. Motilal Banarsidass.*
13. *Tagore, Rabindranath. The History of Bharatavarsha / On Nationalism / Greater India.*
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17. *Aurobindo, Sri. The Indian Renaissance / India's Rebirth / On Nationalism.*
18. *Nivedita, Sister. The Web of Indian Life. Kolkata: Advaita Ashrama.*
19. *Durant, Will. The Story of Civilization. Volume 1 – Our Oriental Heritage. New York: Simon & Schuster.*
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24. *Coomaraswamy, Ananda K. Essays on Indian Idealism. New Delhi: Munshiram Manoharlal.*
25. *Danino, Michel. The Invasion That Never Was.*
26. *Kautilya. Arthasastra.*
27. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
28. *Altekar, A. S. The Position of Women in Hindu Civilization. New Delhi: Motilal Banarsidass.*
29. *Sircar, D. C. Studies in the Religious Life of Ancient and Medieval India. New Delhi: Motilal Banarsidass.*
30. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times.New Delhi: Motilal Banarsidass.*
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32. *Dutt, R. C. The Economic History of India. London, 1902.*
33. *Dharampal. Collected Works.*
34. *Dharampal. Archival Compilations (unpublished)*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM233	GLIMPSES OF INDIAN ECONOMY AND POLITY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction

General Introduction; Primitive man and his modes of exchange – barter system; Prehistoric and proto-historicpolity and social organization.

Ancient India – up to 600 B.C.

Early India – the vedic society – the varnashramadharma – socio-political structure of the various institutions based on the four purusarthas; The structure of ancient Indian polity – Rajamandala and Cakravartins – Prajamandala; Socio-economic elements from the two great Epics – Ramayana and Mahabharata – the concept of the ideal King(Sri Rama) and the ideal state (Ramarajya) – Yudhisthira's ramarajya; Sarasvati - Sindhu civilization and India'strade links with other ancient civilizations; Towards chiefdoms and kingdoms – transformation of the polity: kingship – from gopati to bhupati; The mahajanapadas and the emergence of the srenis – states and cities of theIndo-Gangetic plain.

Unit 2

Classical India: 600B.C. – 1200 A.D.

The rise of Magadha, emergence of new religions – Buddhism and Jainism – and the resultant socio-economic impact; The emergence of the empire – the Mauryan Economy and Kautilya's Arthasastra; of Politics and trade –the rise of the Mercantile Community; Elements from the age of the Kushanas and the Great Guptas; India's maritime trade; Dharma at the bedrock of Indian polity – the concept of Digvijaya: dharma-vijaya, lobha-vijaya and asura-vijaya; Glimpses into the south Indian economies: political economies of the peninsula – Chalukyas, Rashtrakutas and Cholas

Medieval India: 1200 A.D. – 1720 A.D.

Advent of Islam – changes in the social institutions; Medieval India – agrarian economy, non-agricultural productionand urban economy, currency system; Vijayanagara samrajya and maritime trade – the story of Indian supremacyin the Indian Ocean region; Aspects of Mughal administration and economy; The Maratha and other provincial economies.

Unit 3

Modern India: 1720 - 1947

the Indian market and economy before the arrival of the European traders; Colonisation and British supremacy (dismantling of everything that was 'traditional' or 'Indian') – British attitude towards Indian trade, commerce and economy and the resultant ruining of Indian economy and business – man-made famines – the signs of renaissance:banking and other business undertakings by the natives (the members of the early Tagore family, the merchants ofSurat and Porbander, businessmen of Bombay, etc. may be referred to here) – the evolution of the modern bankingsystem; Glimpses into British administration of India and administrative models; The National movement and nationalist undertakings in business and industry: the Tatas and the Birlas; Modern India: the growth of large- scale industry – irrigation and railways – money and credit – foreign trade; Towards partition – birth of two new nations

– division of property; The writing of the Indian Constitution – India becomes a democratic republic – a new polity is in place.

Independent India – from 1947

India since Independence – the saga of socio-political movements; Indian economy since Independence – the fiscal system – the five year plans – liberalisation – the GATT and after; Globalisation and Indian economy; Impact ofscience and (new/ emerging) technology on Indian economy; Histories of select Indian business houses and business entrepreneurship.

Conclusion

REFERENCES:

1. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*
   Kautilya. Arthasastra.

2. *Altekar, A. S. State and Government in Ancient India. New Delhi: Motilal Banarsidass.*
3. *Sircar, D. C. Studies in the Political and Administrative Systems in Ancient and Medieval Times. New Delhi: Motilal Banarsidass.*
4. *Dutt, R. C. The Economic History of India. London, 1902.*
5. *Dharampal. Collected Works (Volumes IV & V).*
6. *Dharampal. Archival Compilations (unpublished).*
7. *Bajaj, Jitendra & M. D. Srinivas. Indian Economy and Polity. Chennai: Centre for Policy Studies.*
8. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
9. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
10. *Tripathi, Dwijendra. The Oxford History of Indian Business. New Delhi: Oxford University Press, 2004.*
11. *McGuire, John, et al, eds. Evolution of World Economy, Precious Metals and India. New Delhi: Oxford University Press, 2001.*
12. *Tripathi, Dwijendra and Jyoti Jumani. The Concise Oxford History of Indian Business. New Delhi: Oxford University Press, 2007.*
13. *Kudaisya, Medha M. The Life and Times of G. D. Birla. New Delhi: Oxford University Press, 2003.*
14. *Raychaudhuri, Tapan and Irfan Haib, eds. The Cambridge Economic History of India. Volume*
15. *New Delhi: Orient Longman, 2004.*
16. *Kumar, Dharma, ed. The Cambridge Economic History of India. Volume 2. New Delhi: Orient Longman, 2005.*
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18. *Mambro, Arvind ed. J. R. D. Tata: Letters. New Delhi: Rupa & Co., 2004.*
19. *Lala, R. M., For the Love of India: The Life and Times of Jamsetji Tata. New Delhi: Penguin, 2006.*
20. *Thapar, Romila. The Penguin History of Early India: From the Origins to AD 1300. New Delhi Penguin, 2002.*
21. *Majumdar, R. C., et. al. An Advanced History of India. Macmillan.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM234	HEALTH AND LIFESTYLE	L-T-P-C: 2-0-0-2

SyllabusUnit 1

Introduction to Health
Health is wealth; Role of lifestyle habits on health; Importance of adolescence; Stages, Characteristics and changes during adolescence; Nutritional needs during adolescence why healthy lifestyle is important for adolescence. Eating Habits - eating disorders, skipping breakfast, junk food consumption.

Practicals **-** *Therapeutic Diets*

Unit 2

Food and Nutritional Requirements during Adolescence
Fluid intake; nutrition related problems; lifestyle related problems, Role of physical activity; resting pattern andpostures, Personal habits – alcoholism, and other tobacco products, electronic addiction etc

Practicals **-** *Ethnic Foods*

Unit 3

Need for a Positive Life Style Change
Peer pressure & procrastination, Stress, depression, suicidal tendency, Mini project review and viva, Whole portions revision.

Practical **-** *Cooking without Fire or Wire-healthy Snacks*

TEXTBOOKS:

1. *B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

REFERENCE BOOKS:

1. *K Park "Textbook of preventive and social medicine", 2010.*
2. *WHO Report on Adolescent Health: 2010*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM235	INDIAN CLASSICS FOR THE TWENTY-FIRST CENTURY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Introductory study of the Bhagavad Gita and the Upanishads.

Unit 2
The relevance of these classics in a modern age.

Unit 3
Goals of human life - existential problems and their solutions in the light of these classics etc.

REFERENCE:
The Bhagavad Gita, Commentary by Swami Chinmayananda

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM236	INTRODUCTION TO INDIA STUDIES	L-T-P-C: 2-0-0-2

PREAMBLE:

This paper will introduce the students to the multiple dimensions of the contribution of India to the fields of philosophy, art, literature, physical and social sciences. The paper intends to give an insight to the students aboutthe far-reaching contributions of India to world culture and thought during the course of its long journey from thehoary antiquity to the present times. Every nation takes pride in its achievements and it is this sense of pride andreverence towards the achievements that lays the foundation for its all-round progress.

SyllabusUnit 1
A brief outline of Indian history from prehistoric times to the present times.

Contributions of India to world culture and civilization: Indian Philosophy and Religion; Art and Literature; Physical and Social Sciences.

Unit 2
Modern India: Challenges and Possibilities.

Scientific and technological progress in post-independence era; Socio-cultural and political movements after independence; Challenges before the nation today - unemployment – corruption – degradation of cultural and moral values - creation of a new system of education; Creation of a modern and vibrant society rooted in traditional values.

Unit 3
Modern Indian Writing in English: Trends in Contemporary Indian Literature in English.

TEXTBOOK:
Material given by the Faculty

BACKGROUND LITERATURE:

1. *Selections from The Cultural Heritage of India, 6 volumes, Ramakrishna Mission Institute of Culture (Kolkata) publication.*
2. *Selections from the Complete Works of Swami Vivekananda, Advaita Ashrama publication.*
3. *Invitations to Indian Philosophy, T. M. P. Mahadevan, University of Madras, Chennai.*
4. *Outlines of Indian Philosophy, M. Hiriyanna, MLBD.*
5. *An Advanced History of India, R. C. Majumdar et al, Macmillan.*
6. *India Since 1526, V. D. Mahajan, S. Chand & Company*
7. *The Indian Renaissance, Sri Aurobindo.*
8. *India's Rebirth, Sri Aurobindo.*
9. *On Nationalism, Sri Aurobindo.*
10. *The Story of Civilization, Volume I: Our Oriental Heritage, Will Durant, Simonand Schuster, New York.*
11. *Eternal Values for a Changing Society, Swami Ranganathananda, Bharatiya Vidya Bhavan.*
12. *Universal Message of the Bhagavad Gita, Swami Ranganathananda, Advaita Ashrama.*
13. *Awaken Children: Conversations with Mata Amritanandamayi*
14. *Indian Aesthetics, V. S. Seturaman, Macmillan.*
15. *Indian Philosophy of Beauty, T. P. Ramachandran, University of Madras, Chennai.*
16. *Web of Indian Thought, Sister Nivedita*
17. *Essays on Indian Nationalism, Anand Kumaraswamy*
18. *Comparative Aesthetics, Volume 2, Kanti Chandra Pandey, Chowkhamba, Varanasi*
19. *The Invasion That Never Was, Michel Danino*
20. *Samskara, U. R. Ananthamurthy, OUP.*
21. *Hayavadana, Girish Karnard, OUP.*

22. *Naga-Mandala, Girish Karnard, OUP.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM237	**INTRODUCTION TO SANSKRIT LANGUAGE AND LITERATURE**	**L-T-P-C: 2-0-0-2**

OBJECTIVES:

To familiarize students with Sanskrit language; to introduce students to various knowledge traditions in Sanskrit;to help students appreciate and imbibe India’s ancient culture and values.

SyllabusUnit 1

Sanskrit Language – Vakya Vyavahara - Introduction to Sanskrit language - Devanagari script and Sanskrit alphabet - Vowels and Consonants – Pronunciation - Classification of Consonants – Samyukthakshara Words – Nouns and Verbs - Cases – Introduction to Numbers and Time – Verbs: Singular, Dual and Plural – SarvaNamas: First Person, Second Person, Third Person – Tenses: Past, Present and Future -Words for Communication – Selected Slokas – MoralStories – Subhashithas – Riddles.

Unit 2

Language Studies - Role of Sanskrit in Indian & World Languages.

Unit 3

Introduction to Sanskrit Classical Literature – KavyaTradition – Drama Tradition - Stotra Tradition – Panchatantra Stories.

Unit 4

Introduction to Sanskrit Technical Literature – Astronomy – Physics – Chemistry – Botany – Engineering – Aeronautics – Ayurveda – Mathematics – Medicine – Architecture - Tradition of Indian Art – Administration –Agriculture.

Unit 5

Indology Studies – Perspectives and Innovations.

TEXTBOOKS AND REFERENCE BOOKS:

1. *Vakya Vyavahara- Prof. Vempaty Kutumba Sastri, Rashtriya Sanskrit Sansthan, New Delhi*
2. *The Wonder that is Sanskrit - Dr.Sampadananda Mishra, New Delhi*
3. *Science in Sanskrit – Samskritha Bharathi, NewDelhi*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM238	NATIONAL SERVICE SCHEME	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Introduction to Basic Concepts of NSS: History, philosophy, aims and objectives of NSS, Emblem, flag, motto,song, badge etc., Organisational structure, roles and responsibilities of various NSS functionaries.
NSS Programmes and Activities: Concept of regular activities, special campaigning, Day Camps, Basis of adoption of village / slums, methodology of conducting survey, financial pattern of the scheme, other youth programme/schemes of GOI, Coordination with different agencies, Maintenance of the Diary.

Unit 2

Volunteerism and Shramdan: Indian Tradition of volunteerism, Needs and importance of volunteerism, Motivation and Constraints of volunteerism, Shramdan as part of volunteerism, Amalabharatam Campaign, Swatch Bharath.

Unit 3

Understanding youth: Definition, profile and categories of youth, Issues, challenges and opportunities for youth, Youth as an agent of social change.
Youth and Yoga: History, philosophy and concept of Yoga, Myths and misconceptions about Yoga, Different Yoga traditions and their impacts, Yoga as a preventive and curative method, Yoga as a tool for healthy life style

Unit 4

Youth Development Programmes in India: National Youth Policy, Youth development programmes at the national level, state level and voluntary sector, youth-focused and youth-led organizations.
Youth and Crime: Sociological and psychological factors influencing youth crime, Peer mentoring in preventing crimes, Awareness about Anti-Ragging, Cyber Crime and its prevention, Juvenile Justice.

Unit 5

Environmental Issues: Environment conservation, enrichment and sustainability, climate change, waste management, rain water harvesting, energy conservation, waste land development.

Project Work / Practical

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM239	PSYCHOLOGY FOR EFFECTIVE LIVING	L-T-P-C: 2-0-0-2

Course Objectives

1. To help students acquire the basic knowledge of behavior and effective living
2. To create an awareness of the hazards of health compromising behaviours
3. To develop and strengthen the tools required to handle the adversities of life

Course Outcome

CO 1: Understand the basic concepts of Behavioral PsychologyCO 2:
Demonstrate self reflective skills through activities
CO 3: Apply the knowledge of psychology to relieve stress
CO 4: Analyse the adverse effects of health compromising behaviours.
CO 5: Evaluate and use guided techniques to overcome and cope with stress related problems.

CO-PO Mapping

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

SyllabusUnit 1

Self-Awareness & Self-Motivation
Self analysis through SWOT, Johari Window, Maslow's hierarchy of motivation, importance of self esteem and enhancement of self esteem.

Unit 2

The Nature and Coping of Stress
Conflict, Relationship issues, PTSD. Stress – stressors – eustress - distress, coping with stress, stress management techniques.

Unit 3

Application of Health Psychology
Health compromising behaviours, substance abuse and addiction.

TEXTBOOKS:

1. *V. D. Swaminathan & K. V. Kaliappan "Psychology for effective living - An introduction to Health*
2. *Psychology. 2nd edition Robert J. Gatchel, Andrew Baum & David S. Krantz, McGraw Hill.*

REFERENCE BOOKS:

1. *S. Sunder, ‘Textbook of Rehabilitation’, 2nd edition, Jaypee Brothers, New Delhi. 2002.*
2. *Weiben & Lloyd, ‘Psychology applied to Modern Life’, Thompson Learning, Asia Ltd.2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM240	PSYCHOLOGY FOR ENGINEERS	L-T-P-C: 2-0-0-2

Course Objectives:

1. To strengthen the fundamental knowledge of human behavior
2. To strengthen the ability to understand the basic nature and behavior of humans in organizations as a whole
3. To connect the concepts of psychology to personal and professional life

Course Outcome

CO 1: Understand the fundamental processes underlying human behavior such as learning, motivation, individual differences, intelligence and personality.
CO 2: Apply the principles of psychology in day- to- day life for a better understanding of oneself and others.
CO 3: Apply the knowledge of Psychology to improve study skills and learning methods
CO 4: Apply the concepts of defense mechanisms to safeguard against abusive relationships and to nurture healthy relationships.

CO-PO Mapping

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

SyllabusUnit 1
Psychology of Adolescents: Adolescence and its characteristics.

Unit 2
Learning, Memory & Study Skills: Definitions, types, principles of reinforcement, techniques for improving study skills, Mnemonics.

Unit 3
Attention & Perception: Definition, types of attention, perception.

TEXTBOOKS:

1. *S. K. Mangal, "General Psychology", Sterling Publishers Pvt. Ltd.2007*
2. *Baron A. Robert, "Psychology", Prentice Hall of India. New Delhi 2001*

REFERENCE BOOKS:

1. *Elizabeth B. Hurlock, Developmental Psychology* **-** *A life span approach, 6th edition.*
2. *Feldman, Understanding Psychology, McGraw Hill, 2000.*
3. *Clifford Morgan, Richard King, John Scholper, "Introduction to Psychology", Tata Mcgraw Hill, Pvt Ltd 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM241	SCIENCE AND SOCIETY - AN INDIAN PERSPECTIVE	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Introduction
Western and Indian views of science and technology
Introduction; Francis Bacon: the first philosopher of modern science; The Indian tradition in science andtechnology: an overview.

Unit 2
Indian sciences
Introduction; Ancient Indian medicine: towards an unbiased perspective; Indian approach to logic; The methodology of Indian mathematics; Revision of the traditional Indian planetary model by Nilakantha Somasutvan in circa 1500 AD

Science and technology under the British rule
Introduction; Indian agriculture before modernization; The story of modern forestry in India; The building ofNew Delhi

Unit 3
Science and technology in Independent India
Introduction; An assessment of traditional and modern energy resources; Green revolution: a historical perspective; Impact of modernisation on milk and oilseeds economy; Planning without the spirit and thedetermination.

Building upon the Indian tradition
Introduction; Regeneration of Indian national resources; Annamahatmyam and Annam Bahu Kurvita: recollecting the classical Indian discipline of growing and sharing food in plenty and regeneration of Indian agriculture to ensure food for all in plenty.

Conclusion

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1. *Joseph, George Gheverghese. The Crest of the Peacock: Non-European Roots of Mathematics. London: Penguin (UK), 2003.*
2. *Iyengar, C. N. Srinivasa. History of Hindu Mathematics. Lahore: 1935, 1938 (2 Parts).*
3. *Amma, T. A. Saraswati. Geometry in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
4. *Bag, A. K. Mathematics in Ancient and Medieval India. Varanasi: Motilal Banarsidass, 1979.*
5. *Sarma K. V. & B. V. Subbarayappa. Indian Astronomy: A Source-Book. Bombay: Nehru Centre, 1985.*
6. *Sriram, M. S. et. al. eds. 500 Years of Tantrasangraha: A Landmark in the History of Astronomy. Shimla: Indian Institute of Advanced Study, 2002.*
7. *Bajaj, Jitendra & M. D. Srinivas. Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty.Shimla: Indian Institute of Advanced Study, 2001.*
8. *Bajaj, Jitendra ed. Report of the Seminar on Food for All: The Classical Indian Discipline of Growing and Sharing Food in Plenty. Chennai: Centre for Policy Studies, 2001.*
9. *Bajaj, Jitendra & M. D. Srinivas. Annam Bahu Kurvita: Recollecting the Indian Discipline of Growing and Sharing Food in Plenty. Madras: Centre for Policy Studies, 1996.*
10. *Parameswaran, S. The Golden Age of Indian Mathematics. Kochi: Swadeshi Science Movement.*
11. *Somayaji, D. A. A Critical Study of Ancient Hindu Astronomy. Dharwar: 1972.*
12. *Sen, S. N. & K. V. Sarma eds. A History of Indian Astronomy. New Delhi, 1985.*
13. *Rao, S. Balachandra. Indian Astronomy: An Introduction. Hyderabad: Universities Press, 2000.*
14. *Bose, D. M. et. al. A Concise History of Science in India. New Delhi: 1971.*
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16. *Bajaj, Jitendra & M. D. Srinivas. Timeless India, Resurgent India. Chennai: Centre for Policy Studies.*
17. *Joshi, Murli Manohar. Science, Sustainability and Indian National Resurgence. Chennai: Centre for Policy Studies, 2008.*
18. *The Cultural Heritage of India. Kolkata: Ramakrishna Mission Institute of Culture.*

** The syllabus and the study material in use herein has been developed out of a 'summer programme' offered by the Centre for Policy Studies (CPS), Chennai at the Indian Institute of Advanced Study (IIAS), Rashtrapati Nivas, Shimla, sometime ago. The same has been very kindly made available to us by Professors Dr M.D. Srinivas (Chairman) and Dr J.K. Bajaj (Director) of the CPS.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM242	THE MESSAGE OF BHAGWAD GITA	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Introduction: Relevance of Bhagavad Gita today – Background of Mahabharatha. ArjunaVishada

Yoga: Arjuna's Anguish and Confusion – Symbolism of Arjuna's Chariot.

Sankhya Yoga: Importance of Self-knowledge – Deathlessness: Indestructibility of Consciousness – Being Established in Wisdom – Qualities of a Sthita-prajna.

Unit 2
Karma Yoga: Yoga of Action – Living in the Present – Dedicated Action without Anxiety over Results - Conceptof Swadharma.

Dhyana Yoga: Tuning the Mind – Quantity, Quality and Direction of Thoughts – Reaching Inner Silence.

Unit 3
Bhakti Yoga: Yoga of Devotion – Form and Formless Aspects of the Divine – Inner Qualities of a True Devotee.

GunatrayaVibhaga Yoga: Dynamics of the Three Gunas: Tamas, Rajas, Sattva – Going Beyond the Three Gunas – Description of a Gunatheetha.

TEXTBOOKS / REFERENCES:

1. *Swami Chinmayananda, "The Holy Geeta", Central Chinmaya Mission Trust, 2002.*
2. *Swami Chinmayananda, "A Manual of Self Unfoldment", Central Chinmaya Mission Trust, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM243	THE MESSAGE OF THE UPANISHADS	L-T-P-C: 2-0-0-2

OBJECTIVES:

To give students an introduction to the basic ideas contained in the Upanishads; and explores how their messagecan be applied in daily life for achieving excellence.

SyllabusUnit 1
An Introduction to the Principal Upanishads and the Bhagavad Gita - Inquiry into the mystery of nature - Sruti versus Smrti - Sanatana Dharma: its uniqueness - The Upanishads and Indian Culture - Upanishads and ModernScience.

Unit 2
The challenge of human experience & problems discussed in the Upanishads – the True nature of Man – theMoving power of the Spirit – The Message of Fearlessness – Universal Man - The central problems of theUpanishads – Ultimate reality – the nature of Atman - the different manifestations of consciousness.

Unit 3
Upanishad Personalities - episodes from their lives and essential teachings: Yajnavalkya, Aruni, Uddalaka, Pippalada,Satyakama Jabala, Svetaketu, Nachiketas, Upakosala, Chakrayana Ushasti, Raikva, Kapila and Janaka. Important verses from Upanishads - Discussion of Sage Pippalada's answers to the six questions in Prasnopanishad.

REFERENCES:

1. *The Message of the Upanishads by Swami Ranganathananda, Bharatiya Vidya Bhavan*
2. *Eight Upanishads with the commentary of Sankaracharya, Advaita Ashrama*
3. *Indian Philosophy by Dr. S. Radhakrishnan, Oxford University Press*
4. *Essentials of Upanishads by R L Kashyap, SAKSI, Bangalore*
5. *Upanishads in Daily Life, Sri Ramakrishna Math, Mylapore.*
6. *Eternal stories of the Upanishads by Thomas Egenes and Kumuda Reddy*
7. *Upanishad Ganga series – Chinmaya Creations*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23HUM244	UNDERSTANDING SCIENCE OF FOOD AND NUTRITION	L-T-P-C: 2-0-0-2

Course Objectives:

- To introduce the significance of food, nutrients, locally available food resources, synergic food combinations, good cooking methods and importance of diversity in foods
- To understand nutritional imbalances and chronic diseases associated with the quality of food.
- To gain awareness about the quality of food - Organic food, genetically modified food, adulterated food, allergic food, , food poisoning and food safety.
- To understand food preservation processing, packaging and the use of additives.

Course Outcome:

CO1: Acquire knowledge about the various food and food groups
CO2: Understand nutritional imbalances and chronic diseases prevailing among different age groups.CO3: Understand the significance of safe food and apply the food safety standards
CO4: Demonstrate skills of food processing, preservation and packaging methods with or without additives CO5: Evaluate the quality of food based on the theoretical knowledge of Food and Nutrition

CO-PO Mapping:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1		1	1			1	2	1	1	1	1	3
CO 2		1	1			1	1	1	1	1	1	3
CO 3		1	1			1	1	1	1	1	1	3
CO 4		1	1			1	1	1	1	1	1	3
CO 5		1	1			1	2	1	2	1	1	3

SyllabusUnit 1

Food and Food Groups
Introduction to foods, food groups, locally available foods, Nutrients, Cooking methods, Synergy between foods, Science behind foods, Food allergies, food poisoning, food safety standards.

Cookery Practicals - *Balanced Diet*

Unit 2

Nutrients and Nutrition
Nutrition through life cycle, RDA, Nutrition in disease, Adulteration of foods & Food additives, Packaging and labeling of foods.

Practicals - *Traditional Foods*

Unit 3

Introduction to Food Biotechnology
Future foods - Organic foods and genetically modified foods, Fortification of foodsvalue addition of foods, functional foods, Nutraceuticals, supplementary foods, Processing and preservation of foods, applications of food

technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advancedresearch.

Practicals **-** *Value added foods*

TEXTBOOKS:

1. *N. Shakuntalamanay, M. Shadaksharaswamy, "Food Facts and principles", New age international (P) ltd, publishers, 2005.*
2. *B. Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*

REFERENCE BOOKS:

1. *B. Srilakshmi, "Food Science", New age international (P) ltd, publishers, 2008.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23JAP230	PROFICIENCY IN JAPANESE LANGUAGE (LOWER)	L-T-P-C: 2-0-0-2

Syllabus

This paper will introduce the basics of Japanese language. Students will be taught the language through various activities like writing, reading, singing songs, showing Japanese movies etc. Moreover this paper intends to givea thorough knowledge on Japanese scripts that is Hiragana and Katakana. Classes will be conducted throughoutin Japanese class only. Students will be able to make conversations with each other in Japanese. Students can make self-introduction and will be able to write letters in Japanese. All the students will be given a text on Japanese verbs and tenses.

Students can know about the Japanese culture and the lifestyle. Calligraphy is also a part of this paper. Informal sessions will be conducted occasionally, in which students can sing Japanese songs, watch Japanese movies, do Origami – pattern making using paper.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23JAP231	PROFICIENCY IN JAPANESE LANGUAGE (HIGHER)	L-T-P-C: 2-0-0-2

Syllabus

Students will be taught the third and the most commonly used Japanese script, Kanji. Students will be taught towrite as well as speak.

Students will be given detailed lectures on Calligraphy.

This version of the course includes a new project where the students should make a short movie in Japaneselanguage selecting their own topics.

By the end of the semester they the students will master the subject in all means. They will be able to speak Japanese as fluently as they speak English. Students will be encouraged to write stories and songs in Japaneselanguage themselves.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23KAN230	KANNADA I	L-T-P-C: 2-0-0-2

OBJECTIVES:

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

SyllabusUnit 1
Adalitha Kannada: bhashe, swaroopa, belavanigeya kiru parichaya Paaribhaashika padagalu
Vocabulary Building

Unit 2
Prabhandha – Vyaaghra Geethe - A. N. Murthy Rao
Prabhandha – Baredidi…baredidi, Baduku mugiyuvudilla allige…- Nemi Chandra Paragraph writing –Development: comparison, definition, cause & effect Essay – Descriptive & Narrative

Unit 3
Mochi – Bharateepriya
Mosarina Mangamma – Maasti Venkatesh Iyengar Kamalaapurada Hotelnalli – Panje Mangesh Rao Kaanike – B. M. Shree
Geleyanobbanige bareda Kaagada – Dr. G. S. Shivarudrappa Moodala Mane – Da. Ra. Bendre
Swathantryada Hanate – K. S. Nissaar Ahmed

Unit 4
Letter W riting - Personal: Congratulation, thanks giving, invitation, condolence

Unit 5
Reading Comprehension; nudigattu, gaadegalu Speaking Skills: Prepared speech, pick and speak

REFERENCES:

1. *H. S. Krishna Swami Iyangar – Adalitha Kannada – Chetana Publication, Mysuru*
2. *N. Murthy Rao – Aleyuva Mana – Kuvempu Kannada Adyayana Samste*
3. *Nemi Chandra – Badhuku Badalisabahudu – Navakarnataka Publication*
4. *Sanna Kathegalu - Prasaranga, Mysuru University , Mysuru*
5. *B. M. Shree – Kannadada Bavuta – Kannada Sahitya Parishattu*
6. *K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna Book House (P) Ltd.*
7. *Dr. G. S. Shivarudrappa – Samagra Kavya – Kamadhenu Pustaka Bhavana*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23KAN231	KANNADA II	L-T-P-C: 2-0-0-2

OBJECTIVES:

To enable the students to acquire basic skills in functional language; to develop independent reading skills andreading for appreciating literary works; to develop functional and creative skills in language; to enable the students to plan, draft, edit & present a piece of writing.

SyllabusUnit 1
Official Correspondence: Adhikrutha patra, prakatane, manavi patra, vanijya patra

Unit 2
Nanna Hanate - Dr. G. S. Shivarudrappa
Mankuthimmana Kaggada Ayda bhagagalu – D. V. Gundappa (Padya Sankhye 5, 20, 22, 23, 25, 44, 344, 345, 346, 601)
Ella Marethiruvaga - K. S. Nissaar Ahmed Saviraru Nadigalu – S Siddalingayya

Unit 3
Sayo Aata – Da. Ra. Bendre

Unit 4
Sarva Sollegala turtu Maha Samelana - Beechi Swarthakkaagi Tyaga - Beechi

Unit 5
Essay writing: Argumentative & Analytical Précis writing

REFERENCES:

1. *H. S. Krishnaswami Iyangar – Adalitha Kannada – Chetan Publication, Mysuru*
2. *Dr. G. S. Shivarudrappa – Samagra Kavya.* **-** *Kamadhenu Pustaka Bhavana*
3. *Shrikanth* **-** *Mankuthimmana Kagga – Taatparya – Sri Ranga Printers & Binders*
4. *K. S. Nissar Ahmed – 75 Bhaavageetegalu – Sapna book house*
5. *Dr. Da. Ra. Bendre – Saayo Aata – Shri Maata Publication*
6. *Beechi – Sahukara Subbamma – Sahitya Prakashana*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAL230	MALAYALAM I	L-T-P-C: 2-0-0-2

Course Objectives:

To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother0-tongue; to learn ourculture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; to create awareness that good language is the sign of complete personality

Course Outcome:

After the completion of the course the student will be able to:

CO1: Understand and inculcate philosophical thoughts and practices
CO2: Understand and appreciate the post modern trends of literature.
CO3: Analyse the literary texts and comprehend the cultural diversity of Kerala
CO4: Distinguish the different genres in Malayalam literature
CO5: Demonstrate the ability to effectively communicate in Malayalam

CO-PO Mapping:

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

SyllabusUnit 1
Ancient poet trio: Adhyatmaramayanam,
Lakshmana Swanthanam (valsa soumitre… mungikidakayal), Ezhuthachan - Medieval period classics –Jnanappana (kalaminnu… vilasangalingane), Poonthanam

Unit 2
Modern Poet trio: Ente Gurunathan, Vallathol Narayana Menon - Critical analysis of the poem.

Unit 3
Short stories from period 1/2/3, Poovanpazham - Vaikaom Muhammed Basheer - Literary & Cultural figures ofKerala and about their literary contributions.

Unit 4
Literary Criticism: Ithihasa studies - Bharatha Paryadanam - Vyasante Chiri - Kuttikrishna Mararu - Outline of literary Criticism in Malayalam Literature - Introduction to Kutti Krishna Mararu & his outlook towards literature & life.

Unit 5
Error-free Malayalam: 1. Language; 2. Clarity of expression; 3. Punctuation – Thettillatha Malayalam

Writing - a. Expansion of ideas; b .Precis Writing; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script /Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

REFERENCES:

1. *P. K. Balakrishnanan, Thunjan padhanangal, D. C. Books, 2007.*
2. *G. Balakrishnan Nair, Jnanappanayum Harinama Keerthanavum, N. B. S, 2005.*
3. *M. N. Karasseri, Basheerinte Poonkavanam, D. C. Books, 2008.*
4. *4 M. N. Vijayan, Marubhoomikal Pookkumbol, D. C. Books, 2010.*
5. *M. Thomas Mathew, Lavanyanubhavathinte Yukthisasthram, National Book Stall, 2009.*
6. *M. Leelavathy, Kavitha Sahityacharitram, National Book Stall, 1998.*
7. *Thayattu Sankaran, Vallathol Kavithapadhanam, D. C. Books, 2004.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23MAL231	**MALAYALAM II**	**L-T-P-C: 2-0-0-2**

OBJECTIVES:

To appreciate the aesthetics & cultural implications; to enhance creative thinking in mother-tongue; to learn ourculture & values; to equip students read & write correct Malayalam; to correct the mistakes in pronunciation; tocreate awareness that good language is the sign of complete personality.

Course Outcome:

After the completion of the course the student will be able to:

CO1: Understand the different cultural influences in linguistic translationCO2: Identify and appreciate the Romantic elements of modern literatureCO3: Analyze the genre of autobiographical writing
CO4: Critically evaluate the significance of historical, political and socio cultural aspects in literatureCO5: Demonstrate good writing skills in Malayalam

CO-PO Mapping:

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

SyllabusUnit 1
Ancient poet trio: Kalayanasougandhikam, (kallum marangalun… namukkennarika vrikodara) Kunjan Nambiar - Critical analysis of his poetry - Ancient Drama: Kerala Sakunthalam (Act 1), Kalidasan (Translated by Attor Krishna Pisharody).

Unit 2
Modern / romantic / contemporary poetry: Manaswini, Changampuzha Krishna Pillai – Romanticism – modernism.

Unit 3
Anthology of short stories from period 3/4/5: Ninte Ormmayku, M. T. Vasudevan Nair - literary contributions of his time

Unit 4
Part of an autobiography / travelogue: Kannerum Kinavum, V. T. Bhattathirippadu - Socio-cultural literature - historical importance.

Unit 5
Error-free Malayalam - 1. Language; 2. Clarity of expression; 3. Punctuation - Thettillatha Malayalam

W riting - a. Expansion of ideas; b. Précis Writing ; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script /Feature / Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciationof literary works (Any one or two as an assignment).

REFERENCES:

1. *Narayana Pillai. P. K, Sahitya Panchanan. Vimarsanathrayam, Kerala Sahitya Academy, 2000*
2. *Sankunni Nair. M. P, Chathravum Chamaravum, D. C. Books, 2010.*
3. *Gupthan Nair. S, Asthiyude Pookkal, D. C Books. 2005*
4. *Panmana Ramachandran Nair, Thettillatha Malayalam, Sariyum thettum etc., D. C. Book, 2006.*
5. *M. Achuthan, Cherukatha-Innale, innu, National Book Stall, 1998.*
6. *N. Krishna Pillai, Kairaliyude Katha, National Book Stall, 2001.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SAN230	SANSKRIT I	L-T-P-C: 2-0-0-2

OBJECTIVES:

To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskritverses and sentences; to help them acquire expertise for self- study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

SyllabusUnit 1
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

Unit 2
Verbs- Singular, Dual and plural – First person, Second person, Third person. Tenses – Past, Present and Future – Atmanepadi and Parasmaipadi-karthariprayoga

Unit 3
Words for communication, slokas, moral stories, subhashithas, riddles (from the books prescribed)

Unit 4
Selected slokas from Valmiki Ramayana, Kalidasa's works and Bhagavad Gita. Ramayana – chapter VIII - verse5, Mahabharata - chapter 174, verse -16, Bhagavad Gita – chapter - IV verse 8, Kalidasa's Sakuntalam Act IV – verse 4

Unit 5
Translation of simple sentences from Sanskrit to English and vice versa.

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. *Prakriya Bhashyam written 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. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar press*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SAN231	SANSKRIT II	L-T-P-C: 2-0-0-2

OBJECTIVES:

To familiarize students with Sanskrit language and literature; to enable them to read and understand Sanskritverses and sentences; to help them acquire expertise for self- study of Sanskrit texts and communication in Sanskrit; to help the students imbibe values of life and Indian culture as propounded in scriptures.

SyllabusUnit 1
Seven cases, indeclinables, sentence making with indeclinables, Saptha karakas.

Unit 2
Ktavatu Pratyaya, Upasargas, Ktvanta, Tumunnanta, Lyabanta. Three Lakaras – brief introduction, Lot lakara.

Unit 3
W ords and sentences for advanced communication. Slokas, moral stories (Pancatantra) Subhashitas, riddles.

Unit 4
Introduction to classical literature, classification of Kavyas, classification of Dramas - The five Mahakavyas, selected slokas from devotional kavyas- Bhagavad Gita – chapter - II verse 47, chapter - IV verse 7, chapter -VI verse 5, chapter - VIII verse 6, chapter - XVI verse 21, Kalidasa's Sakuntala act IV – verse 4, Isavasyopanishat 1st Mantra, Mahabharata chapter 149 verses 14 - 120, Neetisara chapter - III

Unit 5
Translation of paragraphs from Sanskrit to English and vice versa.

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. *Prakriya Bhashyam written 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. *Subhashita Ratna Bhandakara by Kashinath Sharma, published by Nirnayasagar Press.*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SWK230	CORPORATE SOCIAL RESPONSIBILITY	L-T-P-C: 2-0-0-2

Syllabus

Unit 1
Understanding CSR - Evolution, importance, relevance and justification. CSR in the Indian context, corporate strategy. CSR and Indian corporate. Structure of CSR - In the Companies Act 2013 (Section 135); Rules underSection 13; CSR activities, CSR committees, CSR policy, CSR expenditure CSR reporting.

Unit 2
CSR Practices & Policies - CSR practices in domestic and international area; Role and contributions of voluntary organizations to CSR initiatives. Policies; Preparation of CSR policy and process of policy formulation; Government expectations, roles and responsibilities. Role of implementation agency in Section 135 of the Companies Act, 2013. Effective CSR implementation.

Unit 3
Project Management in CSR initiatives - Project and programme; Monitoring and evaluation of CSR Interventions. Reporting - CSR Documentation and report writing. Reporting framework, format and procedure.

REFERENCES:

1. *Corporate Governance, Ethics and Social Responsibility, V Bala Chandran and V Chandrasekaran, PHI learning Private Limited, New Delhi 2011.*
2. *White H. (2005) Challenges in evaluating development effectiveness: Working paper 242, Institute of Development Studies, Brighton.*
3. *UNDP (nd) Governance indicators: A users guide. Oslo: UNDP*
4. *Rao, Subbha (1996) Essentials of Human Resource Management and Industrial Relations, Mumbai, Himalaya*
5. *Rao, V. S. L. (2009) Human Resource Management, New Delhi, Excel Books,*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23SWK231	WORKPLACE MENTAL HEALTH	L-T-P-C: 2-0-0-2

Syllabus

Unit 1

Mental Health – concepts, definition, Bio-psycho-social model of mental health. Mental health and mental illness, characteristics of a mentally healthy individual, Signs and symptoms of mental health issues, presentation of a mentally ill person. Work place – definition, concept, prevalence of mental health issues in the work place, whyinvest in workplace mental health, relationship between mental health and productivity, organizational culture and mental health. Case Study, Activity.

Unit 2

Mental Health Issues in the Workplace: Emotions, Common emotions at the workplace, Mental Health issues - Anger, Anxiety, Stress & Burnout, Depression, Addictions – Substance and Behavioural, Psychotic Disorders - Schizophrenia, Bipolar Disorder, Personality disorders. Crisis Situations - Suicidal behavior, panic attacks, reactions to traumatic events. Stigma and exclusion of affected employees. Other issues –work-life balance, Presenteeism, Harassment, Bullying, Mobbing. Mental Health First Aid - Meaning. Case Study, Activity.

Unit 3

Strategies of Help and Care: Positive impact of work on health, Characteristics of mentally healthy workplace, Employee and employer obligations, Promoting mental health and well being- corporate social responsibility (CSR), an inclusive work environment, Training and awareness raising, managing performance, inclusive recruitment, Supporting individuals-talking about mental health, making reasonable adjustments, Resources and support for employees - Employee Assistance Programme / Provider (EAP), in house counsellor, medical practitioners, online resources and telephone support, 24 hour crisis support, assistance for colleagues and care givers, Legislations. Case Study, Activity.

REFERENCES:

1. *American Psychiatric Association. "Diagnostic and statistical manual of mental disorders: DSM-IV 4th ed." www.terapiacognitiva.eu/dwl/dsm5/DSM-IV.pdf*
2. *American Psychiatric Association. (2000) www.ccsa.ca/Eng/KnowledgeCentre/OurDatabases/ Glossary/Pages/index.aspx.*
3. *Canadian Mental Health Association, Ontario "Workplace mental health promotion, A how to guide"wmhp.cmhaontario.ca/*
4. *Alberta Health Services Mental Health Promotion. (2012). Minding the Workplace: Tips for employees and managers together. Calgary: Alberta Health Services.http:// www.mentalhealthpromotion.net/resources/minding-the-workplace-tips-for-employees-and- managers-together.pdf*
5. *Government of Western Australia, Mental Health Commission. (2014) "Supporting good mental health in the work place." http://www.mentalhealth.wa.gov.au/Libraries/pdf_docs/ supporting_good_mental_health_in_the_workplace_1.sflb.ashx*
6. *Mental Health Act 1987 (India) www.tnhealth.org/mha.htm*
7. *Persons with disabilities Act 1995 (India) socialjustice.nic.in*
8. *The Factories Act 1948 (India) www.caaa.in/Image/19ulabourlawshb.pdf*

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23TAM230	TAMIL I	L-T-P-C: 2-0-0-2

Course Objectives:

- To introduce the students to different literature- Sangam literature, Epics, Bhakthi literatureandmodern literature.
- To improve their ability tocommunicate with creative concepts, and also to introduce them to the usefulness of basicgrammaticalcomponents in Tamil.

Course Outcomes

CO 1: To understand the Sangam literatureCO 2:
To understand the creative literature
CO 3: To understand the literary work on religious scripturesCO 4:
To improve the communication and memory skills
CO 5: To understand the basic grammar components of Tamil language and their usage and applications.CO 6:
Understand creative writing aspects and apply them.

CO-PO Mapping

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

SyllabusUnit1
The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum, ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2
tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.
Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7, 8), maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3
tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4

tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5
tamiḻ moḻi āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimāṟṟam - viḷampara moḻiyamaippu – pēccu - nāṭakam paṭaippu -ciṟukatai, katai, putiṉam paṭaippu.

Textbooks:

1. http:/Www.tamilvu.trg/libirary/libindex.htm.
2. http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
3. Mu.Varatarācaṉ "tamiḻ ilakkiya varalāṟu" cāhitya akaṭemi papḷikēṣaṉs, 2012
4. nā.Vāṉamāmalai "paḻaṅkataikaḷum, paḻamoḻikaḷum" niyū ceñcuri puttaka veḷiyīṭṭakam,
5. 1980,2008
6. nā.Vāṉamāmalai, "tamiḻar nāṭṭuppāṭalkaḷ" niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006
7. poṉ maṇimāṟaṉ "aṭōṉ tamiḻ ilakkaṇam "aṭōṉ papḷiṣiṅ kurūp, vañciyūr,
8. tiruvaṉantapuram, 2007.

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.

23TAM231	TAMIL II	L-T-P-C: 2-0-0-2

Course Objectives

- To learn the history ofTamilliterature.
- To analyze different styles of Tamil Language.
- To strengthen thecreativity in communication, Tamilbasicgrammar and use of computer on Tamil Language.

Course Outcomes

CO 1: Understand the history of Tamil literature.
CO 2: Apply practical and comparative analyses on literature.
CO 3: Understand thinai literature, literature on justice, Pathinenkeelkanaku literature.CO 4: Understand the tamil scholars' service to Tamil language and society.
CO 5: Understand components of Tamil grammar and its usageCO 6: Understand creative writing aspects and apply them

CO-PO Mapping

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

SyllabusUnit 1
The history ofTamilliterature: Nāṭṭupuṟap pāṭalkaḷ, kataikkaḷ, paḻamoḻikaḷ - ciṟukataikaḷ tōṟṟamum vaḷarcciyum, ciṟṟilakkiyaṅkaḷ: Kaliṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai naṭaiyiyal āyvu maṟṟum aimperum – aiñciṟuṅ kāppiyaṅkaḷ toṭarpāṉa ceytikaḷ.

Unit 2
tiṇai ilakkiyamum nītiyilakkiyamum - patiṉeṇkīḻkkaṇakku nūlkaḷ toṭarpāṉa piṟa ceytikaḷ - tirukkuṟaḷ (aṉpu, paṇpu, kalvi, oḻukkam, naṭpu, vāymai, kēḷvi, ceynaṉṟi, periyāraittuṇakkōṭal, viḻippuṇarvu pēṉṟa atikārattil uḷḷa ceytikaḷ.
Aṟanūlkaḷ: Ulakanīti (1-5) – ēlāti (1,3,6). - Cittarkaḷ: Kaṭuveḷi cittar pāṭalkaḷ (āṉantak kaḷippu –1, 4, 6, 7, 8), maṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3
tamiḻ ilakkaṇam: Vākkiya vakaikaḷ – taṉviṉai piṟaviṉai – nērkkūṟṟu ayaṟkūṟṟu

Unit 4
tamiḻaka aṟiñarkaḷiṉ tamiḻ toṇṭum camutāya toṇṭum: Pāratiyār, pāratitācaṉ, paṭṭukkōṭṭai kalyāṇacuntaram, curatā, cujātā, ciṟpi, mēttā, aptul rakumāṉ, na.Piccaimūrtti, akilaṉ, kalki, jī.Yū.Pōp, vīramāmuṉivar, aṇṇā, paritimāṟ kalaiñar, maṟaimalaiyaṭikaḷ.

Unit 5

tamil̲ mol̲i āyvil kaṇiṉi payaṉpāṭu. - Karuttu parimāṟṟam - viḷampara mol̲iyamaippu – pēccu - nāṭakam paṭaippu -ciṟukatai, katai, putiṉam paṭaippu.

Text Books / References

http:/Www.tamilvu.trg/libirary/libindex.htm. http:/Www.tunathamizh.tom/2013/07/blog0post_24.html
Mu.Varatarācaṉ “tamil̲ ilakkiya varalāṟu” cāhitya akaṭemi papḷikēṣaṉs, 2012
nā.Vāṉamāmalai “pal̲aṅkataikaḷum, pal̲amol̲ikaḷum” niyū ceñcuri puttaka veḷiyīṭṭakam, 1980,2008
nā.Vāṉamāmalai, “tamil̲ar nāṭṭuppāṭalkaḷ” niyū ceñcuri puttaka veḷiyīṭṭakam 1964,2006 poṉ maṇimāṟaṉ “aṭōṉ tamil̲ ilakkaṇam “aṭōṉ papḷiṣiṅ kurūp, vañciyū

Evaluation Pattern

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

*CA – Can be Quizzes, Assignment, Projects, and Reports.