

BVVS



Basaveshwar Engineering College, Bagalkote 587103
Department of Electronics and Computer Engineering

Scheme and Syllabus
B.E. in
Electronics and Computer Engineering
for 2024-25 Admitted Batch

BVVS



Basaveshwar Engineering College, Bagalkote 587103
Department of Electronics and Computer Engineering

Vision of the Institute

To be an institution of excellence in education, research and innovation for
a sustainable future

Mission of the Institute

- Develop globally competent professionals for future talent requirements
- Nurture a culture of research, innovation and entrepreneurship
- Promote collaborations, extension and outreach programs for addressing industrial and societal needs
- Imbibe moral and ethical values
- Foster ecological and environmental consciousness

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Basaveshwar Engineering College, Bagalkote 587103
Department of Electronics and Computer Engineering

Vision of the Department

To be recognized as a Center of Excellence for Electronics and Computer Engineering education and research, developing competent professionals with moral and ethical values

Mission of the Department

- Develop professionals with strong fundamentals, technical skills, committed to life-long learning
- Create an environment for interdisciplinary research by collaborating with industries and institutes of higher learning
- Imbibe high moral and ethical values

PEOs of the Department

- Inculcate analytical, logical, programming, and managerial abilities
- Apply software engineering principles and practices to provide software solutions
- Design and develop computational systems for real-life applications

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Basaveshwar Engineering College, Bagalkote 587103
Department of Electronics and Computer Engineering

Program Outcomes

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole- life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Table 1: Breakdown of Credits suggested by VTU /AICTE**Total Credits for BE=160 (as per VTU/AICTE)**

Sl.	Category	VTU	AICTE	BEC Present	BEC Revised
1.	HSMC: HSS (English:2, Kannada:1, UHV:1, Constitution:1, EV:1), HRM:3 (Offered by Dept) = 9 AEC (Scientific foundations of Health: 1, Innovation and design Thinking: 1, SS:2, IKS: 1, MOOCS: 3)= 8	14+8=22	15	9+10=19	9+8=17
2.	BSC: Basic Science Courses (Physics, Chemistry and Mathematics)	22	23	22	22
3.	ESC/ETC: Engineering Science Courses (Basic Elect/ Electronics/ Computer/ Mechanics/ Workshop/ Drawing etc.)	18	17	18	18
4.	PCC: Professional Core Courses	57	61	56	61
5.	PEC: Professional Elective Courses relevant to the branch with at least one course either fully or partially supported by industry	12	12	12	12
6.	OEC: Open Electives Courses/ Subjects from other technical/Arts/Commerce (3 MOOCS + 6)	9	12	09	09
7.	Mini (2) and Major projects (9)/Industrial Internships (10)	20	20	24	21
8.	Mandatory Course: PE, Yoga, NSS, Bridge course Maths 1 and 2 (lateral Entry)	00	00	00	00
Total		160	160	160	160

Table-2: Semester wise Breakdown of Credits

Sem.	BSC	ESC ETC PLC	HSMC	AEC	PCC	PEC	OEC	Proj.	Int.	Total
I	8	9	2	1						20
II	8	9	2	1						20
III	3				17					20
IV	3		1		16					20
V			1	2	9	3	3	2		20
VI				1	13	3	3			20
VII			3		6	6		9		24
VIII				3			3		10	16
Tot.	22	18	9	8	61	12	9	11	10	160



2024-25 Batch

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
Department of Electronics and Computer Engineering
SCHEME OF TEACHING

Semester: I Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	ASC(IC)	BMAE101C	Mathematics-I for EEE Stream	3(42)	0	2(26)	44	05	03	120	50	50	100	04
2.	ASC(IC)	BPHE102C	Applied CPhysics for EEE Stram	3(42)	0	2(26)	44	05	03	120	50	50	100	04
3.	ESC	BECA103C	Basic Electronics	3(42)	0	0	42	03	03	90	50	50	100	03
4.	ESC-I	BXXY104N	ESC-I	2(28)	0	2(26)	28	05	03	90	50	50	100	03
5.	ETC-I	BXXY105B	ETC-I	3(42)	0	0	44	03	03	90	50	50	100	03
6.	AEC	BHSA106C	Communicative English	1(14)	0	0	13	02	01	30	50	50	100	01
7.	HSMC	BHSC107M	Indian Constitution	1(14)	0	0	13	02	01	30	50	50	100	01
8.	AEC/SDC	BHSA108C	Scientific Foundations of Health	1(14)	0	0	13	02	01	30	50	50	100	01
Total				17	00	06					400	400	800	20

Engineering Science Courses-I					Emerging Science Course-I				
Code	Title	L	T	P	Code	Title	L	T	P
BCVA104N	Introduction to Civil Engineering	3	0	0	BAIA105B	Introduction to Cyber Security	3	0	0
BCSA104N	Introduction to C Programming	3	0	0	BCVA105B	Green Building	3	0	0
BEEA104N	Introduction to Electrical Engineering	3	0	0	BCVB105B	Waste Management	3	0	0
BECA104N	Introduction to Electronics and Communication	3	0	0	BECA105B	Introduction to Nanotechnology	3	0	0
BMEA104N	Introduction to Mechanical Engineering	3	0	0	BECB105B	Introduction to Embedded Systems	3	0	0
					BEEA105B	Renewable Energy Sources	3	0	0
					BISA105B	Introduction to Internet of Things (IOT)	3	0	0
					BMEA105B	Smart Materials and Systems	3	0	0

					BMEB105B	Introduction to Sustainable Engineering	3	0	0
					BUEA105B	Emerging Applications of Biosensors	3	0	0

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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
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SCHEME OF TEACHING

Semester: II Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/ 30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	ASC(IC)	BMAE201C	Mathematics-II for EEE Stream	3(42)	0	2(26)	44	05	03	120	50	50	100	04
2.	ASC(IC)	BCHE202C	Chemistry for EEE Stream	3(42)	0	2(26)	44	05	03	120	50	50	100	04
3.	ESC	BMEB203C	Computer-Aided Engineering Drawing	2(28)	0	2(26)	28	05	03	90	50	50	100	03
4.	ESC-II	BXXX204N	ESC-II	3(42)	0	0	42	03	03	90	50	50	100	03
5.	PLC-II	BXXX205D	PLC-II	2(28)	0	2(26)	28	05	03	90	50	50	100	03
6.	AEC	BHSB206C	Professional Writing Skills in English	1(14)	0	0	13	03	01	30	50	50	100	01
7.	HSMC	BHSC207C/ BHSC207C	Samsrutika Kannada/Balake Kannada	1(14)	0	0	13	03	01	30	50	50	100	01
8.	HSMC	BHSB208C	Innovation and Design Thinking	1(14)	0	0	13	03	01	30	50	50	100	01
Total				16	00	08					400	400	800	20

Engineering Science Courses-II					Programming Language Course-II				
Code	Title	L	T	P	Code	Title	L	T	P
BCVA204N	Introduction to Civil Engineering	3	0	0	BCSA205D	Introduction to Web programming	2	0	2
BCSA204N	Introduction to C Programming	2	0	2	BCSB205D	Introduction to Python programming	2	0	2
BEEA204N	Introduction to Electrical Engineering	3	0	0	BCSC205D	Introduction to JAVA programming	2	0	2
BECA204N	Introduction to Electronics and Communication	3	0	0	BCSD205D	Introduction to C++ programming	2	0	2
BMEA204N	Introduction to Mechanical Engineering	3	0	0					

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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
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SCHEME OF TEACHING

Semester: III Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	BSC	BMAE301C	Mathematics III for Electrical Science Stream	3(42)	0	0	42	03	03	90	50	50	100	03
2.	IPCC	BUEA302C	Data Structures with C	3(42)	0	2(26)	44	05	03	120	50	50	100	04
3.	PCC	BUEA303C	Analog and Digital Electronics	4(56)	0	0	58	03	03	120	50	50	100	04
4.	PCC	BUEA304C	Microcontroller and Computer Organization	4(56)	0	0	58	03	03	120	50	50	100	04
5.	PCC	BUEA305C	Object Oriented Programming with C++	2(28)	2(28)	0	28	03	03	90	50	50	100	03
6.	PCCL	BUEA306L	Analog and Digital Laboratory	0	0	2(26)	--	02	02	30	50	50	100	01
7.	PCCL	BUEA307L	Microcontroller Laboratory	0	0	2(26)	--	02	02	30	50	50	100	01
8..	MC	BHSA360M	Yoga	Two Contact hours/week for interaction between the faculty and students				02	--	30	100	--	100	0
		BHSB360M	National Service Scheme (NSS)											
		BHSC360M	Physical Education											
Total				16	02	06				350	350	700	20	



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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
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SCHEME OF TEACHING

Semester: IV Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	PCC	BUEA401C	Discrete Mathematics and Graph Theory	3(42)	0	0	42	03	03	90	50	50	100	03
2.	PCC	BUEA402C	Embedded System Design using ARM	3(42)	0	0	42	03	03	90	50	50	100	03
3.	PCC	BUEA403C	Design and Analysis of Algorithms	3(42)	0	0	42	03	03	90	50	50	100	03
4.	PCC	BUEA404C	Linear ICs and Applications	3(42)	0	0	42	03	03	90	50	50	100	03
5.	PCCL	BUEA405L	ARM Processor Laboratory	0	0	3(39)	--	03	03	45	50	50	100	01
6.	PCCL	BUEA406L	Algorithms Laboratory	0	0	3(39)	--	03	03	45	50	50	100	01
7.	PCCL	BUEA407L	Linear ICs and Applications Laboratory	0	0	2(26)	--	02	02	30	50	50	100	02
8.	BSC	BBTA405C	Biology For Engineers	3(42)	0	0	42	03	03	90	50	50	100	03
9.	HSMC	BHSA424C	Universal Human Values	1(14)	0	0	13	02	01	30	50	50	100	01
10.	MC	BHSA460M	Yoga	Two Contact hours/week for interaction between the faculty and students				02	--	30	100	--	100	00
		BHSB460M	National Service Scheme (NSS)											
		BHSC460M	Physical Education											
Total				15	02	08					450	450	900	20

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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
Department of Electronics and Computer Engineering
SCHEME OF TEACHING

Semester: V Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	IPCC	BUEA501C	Data Science and Visualization	3(42)	0	2(26)	44	05	03	120	50	50	100	04
2.	PCC	BUEA502C	Digital System Design using Verilog	4(56)	0	0	58	03	03	120	50	50	100	04
3.	PCCL	BUEA503L	Verilog Lab	0	0	2(26)	--	02	02	30	50	50	100	01
4.	PEC	BUEX504E	Professional Elective Course	3(42)	0	0	42	03	03	90	50	50	100	03
5.	OEC	BXX5XXN	Open Elective Course	3(42)	0	0	42	03	03	90	50	50	100	03
6.	PROJ	BUEA505P	Mini Project	0	0	4(52)	02	03	03	60	50	50	100	02
7.	AEC	BHSA522C	Quantitative Aptitude and Professional Skills	2(28)	0	0	26	03	03	60	50	50	100	02
8.	HSMC	BBTA523C	Environmental Studies	1(14)	0	0	13	02	01	30	50	50	100	01
9.	MC	BHSA560M	Yoga	Two Contact hours/week for interaction between the faculty and students				02	--	30	100	--	100	00
		BHSB560M	National Service Scheme (NSS)											
		BHSC560M	Physical Education											
Total				16	00	08				400	400	800	20	

Professional Elective Course

BUEA504E	IoT and Applications	BUEC504E	Operating Systems
BUEB504E	Principles of Communication System	BUED504E	Finite Automata and Formal Languages

Open Elective Course

BUEA531N	Electrical Sensors and Transducers
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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
Department of Electronics and Computer Engineering
SCHEME OF TEACHING

Semester: VI Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	IPCC	BUEA601C	Machine Learning	3(42)	0	2(26)	44	05	03	120	50	50	100	04
2.	PCC	BUEA602C	CMOS VLSI Design	4(56)	0	0	58	03	03	120	50	50	100	04
3.	IPCC	BUEA603C	Data Base Management Systems	3(42)	0	2(26)	44	05	03	120	50	50	100	04
4.	PEC	BUEX604E	Professional Elective Course	2(28)	0	2(26)	28	05	03	90	50	50	100	03
				3(42)	0	0	42	03	03					
5.	OEC	BXX6XXN	Open Elective Course	3(42)	0	0	42	03	03	90	50	50	100	03
6.	PCCL	BUEA605L	CMOS VLSI Laboratory	0	0	2(26)	--	02	02	30	50	50	100	01
7.	AEC	BHSA600C	Indian Knowledge System	1(14)	0	0	13	02	01	30	50	50	100	01
8.	MC	BHSA660M	Yoga	Two Contact hours/week for interaction between the faculty and students				02	--	30	100	--	100	00
		BHSB660M	National Service Scheme (NSS)											
		BHSC660M	Physical Education											
Total				19	00	02				350	350	700	20	

Professional Elective Course

BUEA604E	UI/UX Design	BUEC604E	Unix Shell Programming
BUEB604E	Full Stack Development	BUED604E	Cyber Security

Open Elective Course

BUEA631N	Virtual Instrumentation
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**2024-25 Batch**

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
Department of Electronics and Computer Engineering
SCHEME OF TEACHING

Semester: VII Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits © = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	HSMC	BHSA711C	Research Methodology and IPR	3(42)	0	0	42	03	03	90	50	50	100	3
2.	IPCC	BUEA702C	Big Data Analysis	3(42)	0	0	42	03	03	90	50	50	100	3
3.	IPCC	BUEA703C	Computer Networks	2(28)	0	2(26)	28	05	03	90	50	50	100	3
4.	PEC	BUEX704E	Professional Elective Course 1	3(42)	0	0	42	03	03	90	50	50	100	3
				2(28)	0	2(26)	28	05	03					
5.	PEC	BUEX705E	Professional Elective Course 2	3(42)	0	0	42	03	03	90	50	50	100	3
				2(28)	0	2(26)	28	05	03					
				2(28)	2(28)	0	28	03	03					
6.	PROJ	BUEA706P	Major Project	Two Contact hours/week for interaction between the faculty and students				03	03	270	50	50	100	9
Total				20	02	06					300	300	600	24

Professional Elective Course 1			
BUEA704E	System Verilog	BUEC704E	Cloud Computing
BUEB704E	Block Chain Technology	BUED704E	Software Engineering and Project Management
Professional Elective Course 2			
BUEA705E	Data Analytics using R	BUEC705E	Cryptography and Network Security
BUEB705E	Robotics and Automation	BUED705E	Compiler Design

**2024-25 Batch**

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT
Department of Electronics and Computer Engineering
SCHEME OF TEACHING

Semester: VIII Semester (B.E.)

Sl. No.	Course Category	Course Code	Course Title	Teaching-Learning Scheme				Examination Duration (Hrs/Sem.)		Total Hours	Examination Scheme and Evaluation			Credits (C) = Total Hours/30
				L Hrs/Week (Hrs/Sem.)	T Hrs/Week (Hrs/Sem.)	P Hrs/Week (Hrs/Sem.)	Term Work (TW) and Self Learning (SL) (TW+SL) Hrs/Sem.	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
1.	AEC	BUEXXXO	Ability Enhancement Course (Online Courses)	3(42)	0	0	42	03	03	90	50	50	100	3
2.	OEC	BUEXXXO	Open Elective Course (Online Courses)	3(42)	0	0	42	03	03	90	50	50	100	3
3.	INT	BUEA703I	Internship (Industry/Research) (12 - 14 weeks)	Two Contact hours/week for interaction between the faculty and students				03	03	300	50	50	100	10
Total											150	150	300	16

Fifth Semester Syllabus

Course Code :		BUEA501C	Data Science and Visualization	Semester :	05
L:T:P :		3:0:2		Course Type :	IPCC
Hours/Sem.	Teaching :	42+26=68 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	44 Hrs.		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	120Hrs.		Credits :	04

Professional Competency:

Analyze, visualize, and interpret data using modern data science techniques and visualization tools to solve engineering and real-world problems and support informed decision-making.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Apply different techniques to Explore Data Analysis and the Data Science Process
- CO2:** Analyze feature selection algorithms & design a recommender system.
- CO3:** Evaluate data visualization tools and libraries and plot graphs.
- CO4:** Develop different charts and include mathematical expressions

Unit-I

14 Hrs.

Introduction to Data Science: What is Data Science? Big Data and Data Science hype – and getting past the hype, Why now? – Datafication, Current landscape of perspectives, Skill sets. Needed Statistical Inference: Populations and samples, Statistical modelling, probability distributions, fitting a model. **Exploratory Data Analysis and the Data Science Process:** Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA, The Data Science Process.

Unit-II

14 Hrs.

Case Study: Real Direct (online real estate firm), **Feature Generation and Feature Selection:** Extracting Meaning from Data Motivating application: user (customer) retention. Feature Generation (brainstorming, role of domain expertise, and place for imagination), Feature Selection algorithms. Filters; Wrappers; Decision Trees; Random Forests. **Recommendation Systems:** Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine, Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis, **Exercise:** build your own recommendation system.

Unit-III

14 Hrs.

Data Visualization and Data Exploration: Data Visualization, Importance of Data Visualization, Data Wrangling, Tools and Libraries, for Visualization. **Comparison Plots:** Line Chart, Bar Chart and Radar Chart; **Relation Plots:** Scatter Plot, Bubble Plot, Correlogram and Heatmap; **Composition Plots:** Pie Chart, Stacked Bar Chart, Stacked Area Chart, Venn Diagram; **Distribution Plots:** Histogram, Density Plot, Box Plot, Violin Plot; **Geo Plots:** Dot Map, Choropleth Map, Connection Map; What Makes a Good Visualization?

Unit-IV

14 Hrs.

A Deep Dive into Matplotlib: Introduction, Overview of Plots in Matplotlib, **Pyplot Basics:** Creating Figures, Closing Figures, Format, Strings, Plotting, Plotting Using pandas DataFrames, Displaying Figures, Saving Figures; **Basic Text and Legend Functions:** Labels, Titles, Text, Annotations, Legends; Basic Plots: Bar Chart, Pie Chart, Stacked Bar Chart, Stacked Area Chart, Histogram, Box Plot, Scatter Plot,

Bubble Plot; **Layouts:** Subplots, Tight Layout, Radar Charts, GridSpec; **Images:** Basic Image Operations, Writing Mathematical Expressions

Reference Books:

1. Cathy O’Neil and Rachel Schutt, “Doing Data Science”, 2013, O'Reilly Media, Inc O'Reilly Media, Inc
2. Tim Grobmann and Mario Dobler, “Data Visualization workshop”, Packt Publishing, ISBN 9781800568112
3. Anand Rajaraman and Jeffrey D. Ullman, “Mining of Massive Datasets”, 2010, Cambridge University Press
4. Joel Grus, “Data Science from Scratch”, Shroff Publisher /O'Reilly Publisher Media
5. Andy Krik, “A Handbook for Data Driven Design”

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	–	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6)	3	2	–
CO2	3 (WK1, WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK6, WK8)	3	3	1
CO3	2 (WK1, WK2, WK3, WK4)	3 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK6)	3	2	1
CO4	3 (WK1, WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6, WK8)	3	3	2

Course Code :		BUEA502C	Digital System Design using Verilog	Semester :	05
L:T:P :		4:0:0		Course Type :	PCC
Hours/Sem.	Teaching :	56 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	58 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	120 Hrs.		Credits :	04

Professional Competency:

Design, model, simulate, and verify digital systems using Verilog Hardware Description Language (HDL) by applying appropriate modeling techniques and modern Electronic Design Automation (EDA) tools to develop reliable and efficient digital hardware solutions.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the Verilog HDL design flow, language constructs, and modeling concepts used in digital system design. .
- CO2:** Develop and simulate Verilog HDL programs using Gate-level and Dataflow modeling techniques for combinational and sequential digital circuits.
- CO3:** Design and implement digital systems using Behavioral and Structural modeling approaches in Verilog HDL.
- CO4:** Analyze and optimize Verilog HDL programs by effectively utilizing Tasks and Functions to improve modularity, reusability, and code efficiency.

Unit-I

14 Hrs.

Overview of Digital Design with Verilog HDL: Evolution of Computer-Aided Digital Design (CAD), Emergence of HDLs, Typical Design flow, Importance of HDLs, Popularity of Verilog HDL, Trends in HDLs. **Hierarchical Modeling Concepts:** Design Methodologies, Top-down and Bottom-up design methodology, Modules, Instances, Components of a Simulation, Design Block, Stimulus Block (Test Bench) with example.

Unit-II

14 Hrs.

Basic Concepts: Lexical Conventions, Data Types, System Tasks, Compiler Directives. **Modules and Ports:** Modules, Ports, Connecting Ports, Hierarchical Names. **Gate-Level Modeling:** Gate Types-Modeling using basic Verilog gate primitives, Description of AND/OR and BUF/NOT type gates. Gate Delays-Rise, Fall and Turn-Off Delays, Min, Max and Typical Delays.

Unit-III

14 Hrs.

Dataflow Modeling: Continuous assignments, Delay Specification, Expressions, Operators, Operands, Operator Types, Examples. **Behavioral Description:** Structured Procedures, Initial and Always statements, Procedural Assignments Blocking and Non-Blocking statements, Conditional statements, Multiway Branching, Loops, Sequential and Parallel blocks, Examples.

Unit-IV

14 Hrs.

Structural Description: Highlights of Structural Descriptions, Organization of Structural Description, Binding. **Tasks and Functions:** Differences between Tasks and Functions, Declaration and Invocation, Examples.

Reference Books:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", 2nd Edition, Pearson Education.
2. Nazeih M Botros, "HDL programming (VHDL and Verilog)", 2008, John Wiley India Pvt. Ltd.
3. Donald E. Thomas, Philip R. Moorby, "The Verilog Hardware Description Language", 5th Edition, Springer Science + Business Media, LLC.
4. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", 2nd Edition, Pearson (Prentice Hall).
5. Padmanabhan, Tripura Sundari, "Design through Verilog HDL", Wiley, 2016, or earlier.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	–	2 (WK2, WK6)	–	–	–	–	–	1 (WK4)	3	2	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6)	3	3	3
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6, WK8)	3	3	3
CO4	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6, WK8)	3	3	3

Course Code :		BUEA503L	Verilog Laboratory	Semester :	05
L:T:P :		0:0:2		Course Type :	PCCL
Hours/Sem.	Teaching :	26 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	--		SEE Marks :	50
	Exam :	04 Hrs.		Total Marks :	100
	Total Hrs. :	30 Hrs.		Credits :	01

Professional Competency:

Design, implement, simulate, and verify digital systems using Verilog HDL and modern Electronic Design Automation (EDA) tools by applying appropriate hardware modeling techniques to develop reliable and efficient digital solutions.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Exhibit the Verilog Programming skills and model the digital system at different abstraction levels.
- CO2:** Write Test bench to verify the design.
- CO3:** Interface various input and output devices to FPGA.
- CO4:** Develop a complete system for given specifications.

List of Experiments

- Write Verilog program for the following combinational design along with test bench to verify the design:
 - 2 to 4 decoder realization using NAND gates only (structural model).
 - 8 to 3 encoder with priority and without priority (behavioural model).
 - 8 to 1 multiplexer using case statement and if statements.
 - 4-bit binary to gray converter using 1-bit gray to binary converter 1-bit adder and subtractor.
- Model in Verilog for a full adder and add functionality to perform logical operations of XOR, XNOR, AND and OR gates. Write test bench with appropriate input patterns to verify the modeled behaviour.
- Write Verilog code for SR, D and JK and verify the flip flop.
- Write Verilog code for 4-bit BCD synchronous counter.
- Write Verilog code for counter with given input clock and check whether it works as clock divider performing division of clock by 2, 4, 8 and 16. Verify the functionality of the code.
- Write a Verilog code to design a clock divider circuit that generates 1/2 and 1/4th clock from a given input clock. Port the design to FPGA and validate the functionality through oscilloscope.
- Interface a DC motor to FPGA and write Verilog code to change its speed and direction.
- Interface a Stepper motor to FPGA and write Verilog code to control the Stepper motor rotation.
- Interface a DAC to FPGA and write Verilog code to generate Sine wave of frequency F KHz (eg. 200 KHz) frequency.
- Write Verilog code to interface 7-segment display digits/LCD display.
- Write Verilog code using FSM to simulate elevator operation.
- Write Verilog code to interface simple Switches and LEDs.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	2 (WK5)	1 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6)	3	3	3
CO2	2 (WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK6, WK8)	3	3	2
CO3	3 (WK2, WK3, WK4)	2 (WK2, WK3)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6)	3	3	3
CO4	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6, WK8)	3	3	3

Course Code :		BUEA504E	IoT and Applications	Semester :	05
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Develop IoT applications using microcontrollers, cloud platforms, and edge computing technologies for real-time monitoring and control.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the evolution of IoT, IoT networking components, and addressing strategies in IoT.
- CO2:** Analyze various sensing devices and actuator types and demonstrate the processing in IoT.
- CO3:** Apply different connectivity technologies.
- CO4:** Elaborate the need for data analytics and security in IoT.

Unit-I

10 Hrs.

Introduction to Internet of Things: Introduction, Physical design of IoT, Logical Design of IoT, IoT enabling technologies, IoT Levels and Deployment Templates. IoT and M2M: Introduction: M2M, Difference between IoT and M2M, SDN and NFV for IoT, IoT System Management with NETCONF-YANG, Need for IoT Systems Management.

Unit-II

11 Hrs.

AVR Architecture and Assembly Language Programming: The General Purpose Registers in the AVR, The AVR Data Memory, Using Instructions with the Data Memory, AVR Status Register, AVR Data Format and Directives, Introduction to AVR Assembly Programming, The Program Counter and Program ROM Space in the AVR, RISC Architecture in the AVR, **AVR I/O Port Programming:** I/O Port Programming in AVR, I/O Bit Manipulation Programming.

Unit-III

11 Hrs.

Arithmetic, Logical instructions and Programs: Arithmetic Instructions, Signed Number Concepts and Arithmetic Operations, Logical and Compare Instructions, Rotate and Shift Instructions and Data Serialization, BCD and ASCII Conversion. Branch, **Call and Time Delay Loops:** Branch Instructions and Looping, Call Instructions and Stack, AVR Time Delay and Instruction pipeline.

Unit-IV

10 Hrs.

Case Studies illustrating IoT design – Home Automation, Cities, Agriculture Data Analytics for IoT: Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analytics, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis.

Reference Books:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things- A Hands-On Approach", 2014, Universities Press.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st

Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743).

3. Srinivasa K G, "Internet of Things", 2017, Cengage Learning India.
4. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C", 2014, Pearson Education Limited

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	2 (WK5)	1 (WK8)	3 (WK2, WK6)	–	–	1 (WK8)	1 (WK8)	–	2 (WK4, WK6)	3	3	3
CO2	3 (WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	1 (WK8)	1 (WK8)	–	2 (WK6, WK8)	3	3	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1 (WK8)	1 (WK8)	–	2 (WK4, WK6)	3	3	3
CO4	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	1 (WK8)	1 (WK8)	–	2 (WK4, WK6, WK8)	3	3	3

Course Code :		BUEB504E	Principles of Communication Systems	Semester :	05
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
Total Hrs. :		90 Hrs.		Credits :	03

Professional Competency:

Apply the fundamental principles of communication systems to analyze analog and digital communication techniques for reliable information transmission

Course Outcomes:

After completion of the course, student will be able to:

- CO1 : Explain the concepts of probability, random variables, and random processes used in communication systems.
- CO2 : Analyze analog modulation and demodulation techniques including AM, FM, DSB-SC, SSB, and VSB.
- CO3 : Demonstrate the digitization of analog signals using sampling, pulse modulation, PCM, and line coding techniques.
- CO4 : Evaluate the performance of digital modulation techniques such as ASK, PSK, FSK, MSK, and DPSK using error probability concepts.

Unit-I

10 Hrs.

Random Variables and Processes: Introduction, probability, conditional probability. Random variables: Continuous and discrete random variable, statistical averages, distribution and density functions, central limit theorem. **Random processes:** Mean, correlation and covariance function, properties of autocorrelation function, cross-correlation function, Gaussian process.

Unit-II

10 Hrs.

Amplitude Modulation (AM) Fundamentals: AM concepts, time domain and frequency domain description, generation and detection of AM waves, Generation of DSB-SC, SSB, VSB modulation, super heterodyne receiver. **Angle modulation:** Concept of angle modulation, relation between frequency and phase modulation, bandwidth of angle modulated wave. Generation of FM: Direct and indirect methods, PLL, demodulation of FM, pre-emphasis and de-emphasis, FM radio.

Unit-III

11 Hrs.

Digital Representation of Analog Signals: Introduction, sampling process, pulse amplitude modulation, time-division multiplexing. **Pulse Position Modulation (PPM):** Generation and detection of PPM wave, the quantization process. **Pulse Code Modulation:** Sampling, quantization, encoding, line codes, differential encoding.

Unit-IV

11 Hrs.

Digital Modulation Techniques: Digital Modulation formats, Coherent binary modulation techniques (ASK, PSK, FSK), Probability of error for each ASK, PSK, FSK. **Coherent quadrature modulation techniques:** Minimum Shift Keying. **Non-coherent binary modulation techniques:** Frequency Shift Keying and Differential Phase Shift Keying

Reference Books:

1. Louis E Frenzel, Principles of Electronic Communication Systems, Mc Graw Hill Education (India) Private Limited, 3rd Edition, 2016. ISBN: 978-0-07-066755-6.
2. Simon Haykin, Michael Moher, "Communication Systems", John Wiley, India Pvt. Ltd, 5th Edition, 2010, ISBN:978-81-265-2151-7
3. B. P. Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press., 4th edition, 2010, ISBN: 97801980738002.
4. Herbert Taub, Donald L. Schilling, Goutam Saha, "Principles of Communication systems", Mc Graw Hill Education (India) Private Limited, 4th Edition, 2016. ISBN: 978-1-25-902985-1
5. John G. Proakis, Masoulsalehi, "Fundamental of Communication System", 2014, Pearson Education.
6. Sam Shanmugan K. (2006), "Digital and Analog Communication Systems", John Wiley & Son.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	1 (WK3, WK4)	–	–	2 (WK6)	–	–	–	–	–	–	3	2	–
CO2	3 (WK3, WK4)	2 (WK3, WK4)	2 (WK5)	–	3 (WK2, WK6)	–	–	–	–	–	–	3	3	1
CO3	2 (WK3, WK4)	3 (WK3, WK4)	2 (WK5)	1 (WK8)	2 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	2
CO4	2 (WK3, WK4)	2 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3

Course Code		:	BUEC504E	Operating Systems	Semester	:	05
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Apply concepts of process management, CPU scheduling, synchronization, deadlock handling, and inter-process communication to solve system-level problems

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Identify the structure of an operating system and its scheduling mechanism.
- CO2:** Demonstrate the allocation of resources for a process using scheduling algorithm.
- CO3:** Identify root causes of deadlock and provide the solution for deadlock elimination.
- CO4:** Explore about the storage structures and learn about the Linux Operating system.

Unit-I

10 Hrs.

Introduction to operating systems, System structures: What operating systems do; Computer System organization; Computer System architecture; Operating System structure; Operating System operations; Process management; Memory management; Storage management; Protection and Security; Distributed system; Special-purpose systems; Computing environments. **Operating System Services:** User - Operating System interface; System calls; Types of system calls; System programs; Operating system design and implementation; Operating System structure; Virtual machines; Operating System generation; System boot, **Process Management:** Process concept; Process scheduling; Operations on processes; Inter process communication.

Unit-II

11 Hrs.

Multi-threaded Programming: Overview; Multithreading models; Thread Libraries; Threading issues. Process Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms; Multiple-processor scheduling; Thread scheduling. **Process Synchronization:** Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors, **Deadlocks:** Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.

Unit-III

10 Hrs.

Memory Management: Memory management strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation, **Virtual Memory Management:** Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing. **File System, Implementation of File System:** File system: File concept; Access methods; Directory structure; File system mounting; File sharing; Protection: Implementing File system: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management.

Unit-IV

11 Hrs.

Secondary Storage Structures, Protection: Mass storage structures; Disk structure; Disk attachment; Disk

scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of access matrix, Access control, Revocation of access rights, Capability- Based systems, **Case Study:** The Linux Operating System: Linux history; Design principles; Kernel modules; Process management; Scheduling; Memory Management; File systems, Input and output; Inter-process communication.

Reference Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “Operating System Principles”, 7th Edition, Wiley-India, 2006.
2. Ann McHoes Ida M Fylnn, “Understanding Operating System”, Cengage Learning, 6th Edition.
3. D.M Dhamdhere, “Operating Systems: A Concept Based Approach”, 3rd Edition, McGraw- Hill, 2013.
4. P.C.P. Bhatt, “An Introduction to Operating Systems: Concepts and Practice”, 4th Edition, PHI (EEE), 2014.
5. William Stallings, “Operating Systems: Internals and Design Principles”, 6th Edition, Pearson.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	2 (WK3, WK4)	–	–	–	–	–	–	–	–	–	3	2	–
CO2	3 (WK3, WK4)	2 (WK3, WK4)	–	–	–	–	–	–	–	–	–	3	3	1
CO3	2 (WK3, WK4)	3 (WK3, WK4)	–	–	–	–	–	–	–	–	–	3	3	2
CO4	2 (WK3, WK4)	2 (WK3, WK4)	–	–	–	–	–	–	–	–	–	3	3	3

Course Code :		BUED504E	Finite Automata and Formal Languages	Semester :	05
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Apply the principles of finite automata, regular expressions, context-free grammars, and formal languages to model computational systems.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Understand the fundamentals of finite automata theory and regular expressions.
- CO2:** Demonstrate the properties of regular languages and context free grammars and languages.
- CO3:** Demonstrate the properties of context-free Languages and push-down automata.
- CO4:** Exhibit the fundamentals and programming techniques of turing machines and un-decidability concepts.

Unit-I

10 Hrs.

Introduction to Finite Automata: Introduction to Finite Automata; The central concepts of automata theory; Deterministic finite automata; Nondeterministic finite automata. **Finite Automata, Regular Expressions:** An application of finite automata; Finite automata with Epsilon-transitions; Regular expressions; Finite automata and regular expressions; Applications of regular expressions.

Unit-II

11 Hrs.

Regular Languages, Properties of Regular Languages: Regular languages; Proving languages not to be regular languages; Closure properties of regular languages; Decision properties of regular languages; Equivalence and minimization of automata. **Context-Free Grammars and Languages:** Context –free grammars, Parse trees, Applications, Ambiguity in grammars and Languages.

Unit-III

11 Hrs.

Pushdown Automata: Definition of the pushdown automata, The languages of a PDA, Equivalence of PDAs and CFGs, Deterministic pushdown automata. **Properties of Context-Free Languages:** Normal forms for CFGs, The pumping lemma for CFGs, Closure properties of CFLs.

Unit-IV

10 Hrs.

Introduction To Turing Machine: Problems that computer cannot solve, The turning machine, Programming techniques for turing machines, 50 Extensions to the basic turing machines, Turing machine and computers. **Un-decidability:** A language that is not recursively enumerable, An un-decidable problem that is RE, Post's correspondence problem, Other un-decidable problems.

Reference Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, "Introduction to Automata Theory, Languages and Computation", 3rd Edition, 2007, Pearson Education.
2. K.L.P. Mishra, "Theory of Computer Science, Automata, Languages, and Computation", 3rd Edition, 2009, PHI Learning.

Course Code		:	BUEA531N	Electrical Sensors and Transducers	Semester	:	05
L:T:P		:	3:0:0		Course Type	:	OEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Understand the operating principles, characteristics, and performance parameters of electrical sensors and transducers used in measurement and control systems.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Describe the characteristics of various sensors/transducers.
- CO2:** Interpret the construction and working of various sensors/transducers.
- CO3:** Select an appropriate sensor for real time measurement application.
- CO4:** Use an appropriate sensor for designing an engineering solution for real time measurement of process parameter.

Unit-I

11 Hrs.

Introduction to Sensor: Meaning of sensors and transducers, classification of transducers (Mechanical/electrical, Active/passive, Absolute/Modulated output type), Sensor based measurement system, Static characteristics (Accuracy, precision, sensitivity, error, linearity, resolution, hysteresis), Dynamic characteristics (Order and step response of I, II order system) **Resistive Sensors:** Potentiometers, Strain gauges, Resistive temperature detectors (RTD), Thermistors, Magnetoresistors, Light-dependent resistors (LDR), Resistive hygrometer, Resistive gas sensor, Liquid conductivity sensors.

Unit-II

11 Hrs.

Self-Generating Sensors: Thermoelectric sensors: Thermocouples, Piezoelectric sensors, Hall effect sensors, Pyroelectric sensors, Photo voltaic sensors, Electrochemical sensors. **Capacitive Sensors:** Variable capacitors: Differential arrangement, Different applications. Differential capacitor: Principle based on variable are, distance and dielectric property, applications.

Unit-III

10 Hrs.

Inductive Sensors: Variable reluctance type, Eddy current type, LVDT, LVDT applications, Variable transformers: Synchros, Resolvers, Inductosyns. Magnetoelastic and magnetostrictive sensors, Super Quantum Interference Devices (SQUIDS). **Electromagnetic Sensors:** Sensors based on Faraday's law, Linear velocity sensor, Search coil magnetometer, Electromagnetic flow meter.

Unit-IV

10 Hrs.

Digital and Intelligent Sensors: Position encoders, Resonant sensors, Intelligent sensors. **Miscellaneous Sensors:** Sensors based on semiconductor junctions, Sensors based on MOSFET transistors, Fiber optic sensors, Ultrasonic based sensors, Biosensors.

Reference Books:

1. Ramon P. Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Private Ltd.

2. Ian R. Sinclair, "Sensors and Transducers", 3rd Edition, Newnes Publication.
3. D. Patranabis, "Sensors and Transducers", 2nd Edition, PHI.
4. Allan S. Morris, "Measurement and Instrumentation Principles", 3rd Edition, Butterworth and Heinmann Publication.
5. John P. Bentley, "Principles of Measurement Systems", 3rd Edition, 2004, Pearson Publication.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK2, WK3, WK4, WK6)	2 (WK3, WK4, WK8)	2 (WK2, WK6)	–	–	–	1 (WK8)	–	2 (WK8)	2	1	1
CO2	3 (WK1, WK2, WK3, WK4)	2 (WK2, WK3, WK4, WK6)	2 (WK2, WK3, WK4, WK6)	2 (WK3, WK4, WK8)	2 (WK2, WK6)	–	–	–	1 (WK8)	–	2 (WK8)	2	1	1
CO3	3 (WK1, WK2, WK3, WK4)	2 (WK2, WK3, WK4, WK6)	3 (WK2, WK3, WK4, WK6)	3 (WK3, WK4, WK8)	2 (WK2, WK6)	–	–	–	1 (WK8)	–	2 (WK8)	2	1	1
CO4	3 (WK1, WK2, WK4)	2 (WK2, WK3, WK4, WK6)	3 (WK2, WK3, WK4, WK6)	3 (WK3, WK4, WK6)	2 (WK2, WK6)	–	–	–	1 (WK8)	–	2 (WK8)	2	1	1

Course Code		:	BHSA522C	Quantitative Aptitude and Professional Skills	Semester	:	05
L:T:P		:	2:0:0		Course Type	:	AEC
Hours/Sem.	Teaching	:	28Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	28Hrs		SEE Marks	:	50
	Exam	:	04Hrs		Total Marks	:	100
	Total Hrs.	:	60Hrs		Credit	:	00

Professional Competency:

Demonstrate competency in enhancing vocabulary, improving verbal ability, analyzing problems systematically, and solving quantitative problems using appropriate language and numerical techniques.

Course Out comes :

At the end of the course student will be able to

- CO1:** Enhance vocabulary and apply techniques to further improve word usage and language proficiency.
- CO2:** Apply techniques to improve verbal ability in communication and comprehension tasks.
- CO3:** Analyze problems step-by-step and develop appropriate methods for solving them effectively.
- CO4:** Solve quantitative problems by applying appropriate concepts and techniques to improve numerical ability.

Unit-I

7Hrs.

Vocabulary Development: Vocabulary Building Techniques, Root Words, Antonyms & Synonyms, Sentence Completion, Error Detection & Correction, Reading Comprehension

Unit-II

7Hrs.

Numbers, Proportion & Finance: Number System, Factors & Multiples, The God of Math–Linear Equations, Ratio-Proportion-Variation, Percentages, Profit & Loss, Interest, Averages & Allegations

Unit-III

7Hrs.

Time & Probability: Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability

Unit-IV

7Hrs.

Verbal, Analytical, and Visual Reasoning: Human Relations, Direction Tests, Coding Decoding, Clocks and Calendars, Visual Reasoning, Analytical Puzzles, Mathematical, Arrangement & Classification Puzzles

Reference Books:

1. R.S. Aggarwal, "A Modern Approach to Verbal and Non–Verbal Reasoning", Sultan Chand and Sons, New Delhi, 2018
 2. R. S. Aggarwal, "Quantitative Aptitude", Sultan Chand and Sons, New Delhi, 2018
 3. Chopra, "Verbal and Non–Verbal Reasoning", MacMillan India
 4. M Tyra, "Magical Book on Quicker Maths", BSC Publications, 2018
 5. George J Summers, "The Great Book of Puzzles & T easers", Jaico Publishing House, 1989
 6. Shakuntala Devi, "Puzzles to Puzzle You", Orient Paper Backs, New Delhi, 1976
 7. R.S. Aggarwal, "A Modern Approach to Logical Reasoning", Sultan Chand and Sons, New Delhi, 2018
 8. Cambridge Advanced Learner's Dictionary, Cambridge University Press.
- Kaplan's GRE guide

CO-PO Mapping

[illegible]

Course Code : BBTA523C			Environmental Studies	Semester :	05
L:T:P : 1:0:0				Course Type :	MC
Hours/Sem.	Teaching :	14 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	13 Hrs.		SEE Marks :	50
	Exam :	03 Hr.		Total Marks :	100
	Total Hrs. :	30 Hrs.		Credits :	01
Professional Competency:					
Develop the ability to analyze environmental issues and implement sustainable solutions by applying environmental science principles, pollution control measures, and environmental legislation.					
Course Outcomes:					
After completion of the course, student will be able to:					
CO1: Identify natural resources and its uses.					
CO2: Understand pollution and its effects on environment and to implement sustainable future in the work place.					
CO3: Analyze current environmental issues.					
CO4: Apply the waste management techniques in various fields.					
UNIT – I					03 Hrs.
Natural Resources:					
Human activities and their impacts. Environmental Impact Assessment, Renewable Energy : Solar, Wind, Hydropower, Tidal, Ocean thermal, Geo thermal, Biomass energy, Biogas, Biodiesel, Bioethanol, Hydrogen as fuel. Non renewable Energy : Coal, Petroleum, Natural gas, Nuclear energy.					
UNIT – II					04 Hrs.
Environmental Pollution: Water pollution, water quality standards, water borne diseases, Fluoride problem, Air pollution, Noise pollution. Effect of electromagnetic waves. Sustainable future : Concept of sustainable development, threats to sustainability, strategies for sustainable development, Sustainable development goals (SDGs). Environment economics – concept of green building, Circular Economy.					
UNIT – III					03 Hrs.
Current Environmental Issues of concern: Greenhouse Effect- Greenhouse gases and Global Warming, Climate change, ozone layer depletion, Acid rain, Eutrophication, Environmental policy legislation rules & regulations					
UNIT – IV					04Hrs.
Fundamentals of Waste management:					
Solid waste management: Sources, classification, characteristics, collection & transportation, disposal, and processing methods. Hazardous waste management and handling.					
Concept of waste water treatment, Bioremediation.					
Industrial waste management (Case studies: Cement, plastic, chemical, E–waste, food & construction industry waste management).					
Text books					
1. Benny Joseph, “Environmental Studies”, 3 rd Edition, McGraw Hill Education (India) Pvt. Ltd., 2017.					
2. Manjunath, D. L., “Environmental Studies”, 1 st Edition, Pearson Education, New Delhi, 2007.					
3. Anubha Kaushik and C. P. Kaushik, “Perspectives in Environmental Studies”, 8 th Edition, New Age International (P) Ltd., New Delhi, 2025.					
4. P. Meenakshi, “Elements of Environmental Science and Engineering”, 2 nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.					

CO-PO Mapping

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2 (WK1, WK2, WK3, WK4)	–	2 (WK2, WK3, WK5)	–	–	3 (WK1, WK5, WK7)	–	–	–	–	3 (WK8)	3	–	–
CO2	2 (WK1, WK2, WK3, WK4)	–	2 (WK2, WK3, WK5)	–	–	3 (WK1, WK5, WK7)	–	–	–	–	3 (WK8)	3	–	1
CO3	2 (WK1, WK2, WK3, WK4)	–	3 (WK2, WK3, WK5)	–	–	3 (WK1, WK5, WK7)	–	–	–	–	3 (WK8)	3	–	2

Sixth Semester Syllabus

Course Code		:	BUEA601C	Machine Learning	Semester	:	06
L:T:P		:	3:0:2		Course Type	:	IPCC
Hours/Sem.	Teaching	:	42+26=68 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	44Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	04

Professional Competency:

Design, analyze, and implement suitable Machine Learning models and algorithms to extract insights from data and develop intelligent systems for real-world applications.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the fundamental concepts, need, and applications of Machine Learning and its relation to other disciplines.
- CO2:** Apply statistical and analytical techniques for understanding, preparing, and visualizing data in Machine Learning.
- CO3:** Demonstrate concept learning, hypothesis representation, and the use of basic learning algorithms such as Find-S.
- CO4:** Implement and analyze similarity-based, regression, decision tree, clustering, and Bayesian learning algorithms for predictive modeling.

UNIT-I

10 Hrs

Need for Machine Learning, Why Machine Learning is popular? What is Machine Learning? Knowledge Pyramid, Machine Learning in relation to other fields, Types of Machine Learning, Challenges of Machine Learning, Machine Learning Process, Machine Learning Application. **Understanding Data:** Introduction, Big Data Analytics and Types of Analytics, Big Data Analysis Framework.

UNIT-II

11 Hrs

Descriptive Statistics: Introduction: Why Descriptive Statistics in ML? Dataset and Data Types, Univariate Data Analysis & Visualization, Bivariate Data and Multivariate Data. Multivariate Data: What is Multivariate Data? Essential Mathematics for Multivariate Data, Machine Learning and Importance of Probability and Statistics. **Overview of Hypothesis:** Comparing Learning Methods. Introduction to Learning and its types, Designing of Learning System, Concept Learning, Representation of a Hypothesis, Hypothesis space search by Find-S algorithm.

UNIT-III

11 Hrs

Similarity-based Learning: Introduction to Similarity or Instance-based Learning, Nearest-Neighbor Learning, Weighted K-Nearest-Neighbor Algorithm, Nearest Centroid Classifier, Locally Weighted Regression (LWR). Regression Analysis: Introduction to Regression, Introduction to Linearity, Correlation, and Causation, Introduction to Linear Regression, Validation of Regression Methods, Multiple Linear Regression, Polynomial Regression, Logistic.

UNIT-IV	10 Hrs
Decision Tree Learning: Introduction to Decision Tree Learning Model, Decision Tree Induction Algorithms: ID3 and C4.5, Regression Trees, Validating and Pruning of Decision Trees. Clustering: K-Means Clustering. Bayesian Learning: Naïve Bayes Algorithm. Reinforcement Learning: Overview and Scope of Reinforcement Learning, Components of Reinforcement Learning.	
List of experiments	
1. Develop a program to create histograms for all numerical features and analyze the distribution of each feature. Generate box plots for all numerical features and identify any outliers. Use California Housing dataset. 2. Develop a program to compute the correlation matrix to understand the relationships between pairs of features. Visualize the correlation matrix using a heatmap to know which variables have strong positive/negative correlations. Create a pair plot to visualize pairwise relationships between features. Use California Housing dataset. 3. Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2. 4. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples. 5. Develop a program to implement k-Nearest Neighbour algorithm to classify the randomly generated 100 values of x in the range of [0,1]. Perform the following based on dataset generated. a. Label the first 50 points {x1,.....,x50} as follows: if ($x_i \leq 0.5$), then $x_i \in \text{Class1}$, else $x_i \in \text{Class1}$ b. Classify the remaining points, x51,.....,x100 using KNN. Perform this for k=1,2,3,4,5,20,30 6. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. 7. Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression. 8. Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample. 9. Develop a program to implement the Naive Bayesian classifier considering Olivetti Face Data set for training. Compute the accuracy of the classifier, considering a few test data sets. 10. Develop a program to implement k-means clustering using Wisconsin Breast Cancer data set and visualize the clustering result.	
Reference Books:	
1. S. Sridhar and M. Vijayalakshmi, "Machine Learning", Oxford University Press, 2021. 2. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education, 2013. 3. Miroslav Kubat, "An Introduction to Machine Learning", Springer, 2017.	
Web links and Video Lectures (e-Resources):	
• https://www.drssridhar.com/?page_id=1053 • https://www.universitiespress.com/resources?id=9789393330697 • https://onlinecourses.nptel.ac.in/noc23_cs18/preview • https://www.geeksforgeeks.org/machine-learning/ • https://www.w3schools.com/python/python_ml_getting_started.asp • https://www.tutorialspoint.com/machine_learning/index.htm	

CO-PO Mapping:

Course Outcomes	Program Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2 (WK1, WK2, WK3, WK4)	3 (WK, WK2, WK3, WK4)	3	3	--	--	--	- -	--	--	1	2	1	3
CO2	3	2 (WK1, WK2, WK3, WK4)	3 (WK5)	2	2 (WK6)	--	--	- -	1	1	--	1 (WK8)	2	3
CO3	--	2 (WK1, WK2, WK3, WK4)	3 (WK5)	--	3(WK6)	1 (WK1, WK5, WK7)	--	1	1	--	1 (WK8)	--	2	3
CO4	--	2 (WK1, WK2, WK3, WK4)	2 (WK5)	-	--	1 (WK1, WK5, WK7)	--	1	1	--	1 (WK8)	--	2	

Course Code		:	BUEA602C	CMOS VLSI Design	Semester	:	06
L:T:P		:	4:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	56 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	58		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	120 Hrs.		Credits	:	04

Professional Competency:

Demonstrate the ability to analyze, design, and optimize CMOS VLSI circuits and array subsystems by applying principles of MOSFET physics, fabrication processes, and interconnect modeling to improve performance metrics such as delay and power dissipation.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Draw the layout of CMOS circuits; apply the knowledge of fabrication processes and MOSFET transistors in VLSI design..
- CO2:** Draw an RC equivalent circuit of CMOS circuits and estimate delay and power.
- CO3:** Model & design of interconnects in chips, design of combinational circuits.
- CO4:** Design basic building blocks of sequential circuits and memory subsystems using MOSFET transistors.

Unit-I

14 Hrs.

Introduction: A Brief History, Preview, MOS Transistors, CMOS Logic, CMOS Fabrication and Layout, Design Partitioning. **MOS Transistor Theory:** Introduction, Long- Channel I-V Characteristics, C-V Characteristics (simple MOS capacitance models), Non ideal I-V Effects, DC Transfer Characteristics. **CMOS Processing Technology:** Introduction, CMOS Technologies.

Unit-II

14 Hrs.

Delay: Introduction, Transient Response, RC Delay Model, Linear Delay Model (Logical effort, parasitic delay, delay in logic gate, drive), Logical Effort of Paths, **Power:** Introduction, Dynamic Power, Static Power, Energy-Delay Tradeoffs, Power Reduction Techniques, Short-Circuit Power.

Unit-III

14 Hrs.

Interconnect: Introduction (wire Geometry), Interconnect Modeling, Interconnect Impact (Delay, Energy, Cross-talk). **Combinational Circuit Design:** Introduction, Circuit families, Silicon-On-Insulator Circuit Design.

Unit-IV

14 Hrs.

Sequential Circuit Design: Introduction, Circuit Design of Latches and Flip Flops (conventional CMOS latches, conventional CMOS flip flops, pulsed latches, resettable latches and flip flops, enabled latches and flip flops, incorporating logic into latches, dual edge triggered flip flops. **Array Subsystems:** Introduction, SRAM (SRAM cells, ROW circuitry, column circuitry), Read-Only Memory, Serial Access Memories, Content Addressable Memory, Programmable Logic Arrays.

Reference Books:

1. Neil H. E. Weste, David Harris, "CMOS VLSI Design A Circuits and Systems Perspective", Pearson Education Publisher, 4th Edition, 2015.

2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits A Design Perspective", Pearson Education Publisher, 2nd Edition. 2010.
3. John P Uyemura, "Introduction to VLSI Circuits and Systems", Wiley Publication 2002.
4. R. Jacob Baker, Harry W. Li, David E. Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	2 (WK3, WK4)	2 (WK5)	–	2 (WK2, WK6)	–	–	–	–	–	–	3	2	2
CO2	3 (WK3, WK4)	3 (WK3, WK4)	2 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	–	3	2	2
CO3	3 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	3
CO4	3 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3

Course Code :		BUEA603C	Data Base Management System	Semester :	06
L:T:P :		3:0:2		Course Type :	IPCC
Hours/Sem.	Teaching :	42+26=68 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	44 Hrs.		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	120 Hrs.		Credits :	04

Professional Competency:

Apply database administration practices for backup, recovery, access control, and data security in enterprise environments.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Identify, analyze and define database objects, enforce integrity constraints on a database using RDBMS.
- CO2:** Use of Structured Query Language (SQL) for Database Manipulation.
- CO3:** Design and build simple database systems.
- CO4:** Develop application to interact with databases.

Unit-I

11 Hrs.

Introduction to Databases: Introduction, Characteristics of Database Approach, Advantages of using the DBMS Approach, History of Database Applications, **Overview of Database Languages and Architectures:** Data Models, Schemas and Instances. Three schema Architecture and Data Independence, Database Languages and Interfaces, the Database System Environment, **Conceptual Data Modelling using Entities and Relationships:** Entity Types, Entity Sets, Attributes, Roles and Structural Constraints, Weak Entity Types, ER Diagrams, Examples, Specialization and Generalization, **Relational Model:** Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraints Violations.

Unit-II

10 Hrs.

Relational Algebra: Unary and Binary Relational Operations, Additional Relational Operations, (aggregate, grouping, etc.) Examples of Queries in Relational Algebra, **SQL:** Advances Queries: More complex SQL Retrieval Queries, Specifying Constraints as Assertions and Action Triggers, Views in SQL, Schema change statements in SQL. **Database Application Development:** Accessing Databases from Applications, An Introduction to JDBC, JDBC Classes and Interfaces, SQLI, Stored Procedures and Case Study: The Internet Bookshop.

Unit-III

11 Hrs.

Internet Applications: The Three-Tier application Architecture, The Presentation Layer, The Middle Tier, **Normalization:** Database Design Theory – Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for Relation Schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce- Codd Normal Form, Multivalued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, **Normalization Algorithms:** Inference Rules, Equivalence and Minimal Cover, Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Nulls, Dangling, Tuples, Relational

Designs, Further discussion of Multivalued Dependencies and 4NF, Other Dependencies and Normal Forms.

Unit-IV

10 Hrs.

Transaction Processing: Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing schedules based on Recoverability, Characterizing schedules based on Serializability, Transaction support in SQL, **Concurrency Control in Database:** Two-phase locking techniques for Concurrency Control, Concurrency Control based on Timestamp Ordering, Multiversion Concurrency Control Techniques, Validation Concurrency Control Techniques, Granularity of Data Items and Multiple Granularity Locking. **Introduction to Database Recovery Protocols:** Recovery Concepts, NO-UNDO/ REDO recovery based on Deferred Update, Recovery techniques based on Immediate Update, Shadow Paging, Database Backup and Recovery from Catastrophic Failures.

List of Experiments

1. Create a table called Employee & execute the following.
Employee (EMPNO, ENAME, JOB, MANAGER_NO, SAL, COMMISSION)
 - a) Create a user and grant all permissions to the user.
 - b) Insert the any three records in the employee table contains attributes EMPNO, ENAME JOB, MANAGER_NO, SAL, COMMISSION and use rollback. Check the result.
 - c) Add primary key constraint and not null constraint to the employee table.
 - d) Insert null values to the employee table and verify the result.
2. Create a table called Employee that contains attributes EMPNO, ENAME, JOB, MGR, SAL & execute the following.
 - a) Add a column commission with domain to the Employee table.
 - b) Insert any five records into the table.
 - c) Update the column details of job.
 - d) Rename the column of Employ table using alter command.
5. Delete the employee whose Empno is 105.
3. Queries using aggregate functions (COUNT, AVG, MIN, MAX, SUM) Group by, Order by. Employee (E_id, E_name, Age, Salary)
 - a) Create Employee table containing all Records E_id, E_name, Age, Salary.
 - b) Count number of employee names from employeetable.
 - c) Find the Maximum age from employee table.
 - d) Find the Minimum age from employee table.
 - e) Find salaries of employee in Ascending Order.
 - f) Find grouped salaries of employees.
4. Create a row level trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old & new Salary.
CUSTOMERS (ID, NAME, AGE, ADDRESS, SALARY)
5. Create cursor for Employee table & extract the values from the table. Declare the variables, Open the cursor & extract the values from the cursor. Close the cursor.
Employee(E_id, E_name, Age, Salary)
6. Write a PL/SQL block of code using parameterized Cursor, that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table

Course Code		:	BUEA604E	UI/UX Design	Semester	:	06
L:T:P		:	2:0:2		Course Type	:	PEC
Hours/Sem.	Teaching	:	28 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	28		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Design responsive and visually appealing interfaces by applying principles of typography, color theory, layout, navigation, and visual hierarchy

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Build UI for user applications.
- CO2:** Evaluate UX design of any product or application.
- CO3:** Demonstrate UX skills in product development.
- CO4:** Implement sketching principles.

Unit-I

07 Hrs.

Foundations of Design: UI vs. UX Design – Core Stages of Design Thinking – Divergent and Convergent Thinking -Brainstorming and Game storming – Observational Empathy.

Unit-II

07 Hrs.

Foundations of UI Design: Visual and UI Principles – UI Elements and Patterns – Interaction Behaviors and Principles -Branding – Style Guides.

Unit-III

07 Hrs.

Foundation of UX Design: Introduction to User Experience - Why You Should Care About User Experience- Understanding User Experience- Defining The UX Design Process and its Methodology- Research in User Experience Design- Tools and Method Used For Research - User Needs and its Goals- Know About Business Goals.

Unit-IV

07 Hrs.

Wireframing, Prototyping and Testing: Sketching Principles – Sketching Red Routes – Responsive Design – Wireframing – Creating Wireflows – Building a Prototype – Building High-Fidelity Mockups – Designing Efficiently with Tools – Interaction Patterns – Conducting Usability Tests – Other Evaluative User Research Methods -Synthesizing Test Findings – Prototype Iteration.

List of Experiments

1. Designing a Responsive layout for an societal application.
2. Exploring various UI Interaction Patterns.
3. Developing an interface with proper UI Style Guides.
4. Developing Wireflow diagram for application using open source software.
5. Exploring various open source collaborative interface Platform.
6. Hands on Design Thinking Process for a new product.
7. Brainstorming feature for proposed product.
8. Defining the Look and Feel of the new Project.
9. Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles).
10. Identify a customer problem to solve.
11. Conduct end-to-end user research – User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping.

12. Sketch, design with popular tool and build a prototype and perform usability testing and identify improvements.

13. Reference Books:

1. Joel Marsh, "UX for Beginners", 2022, O'Reilly.
2. Jon Yablonski, "Laws of UX using Psychology to Design Better Product and Services," 2021, O'Reilly.
3. Jenifer Tidwell, Charles Brewer, Aynne Valencia, "Designing Interface", 3rd Edition, 2020, O'Reilly.
4. Steve Schoger, Adam Wathan, "Refactoring UI", 2018.
5. Steve Krug, "Don't Make Me Think, Revisited: A Commonsense Approach to Web & Mobile", 3rd Edition, 2015.

Web Links and Video Lectures (e-Resources):

1. <https://www.nngroup.com/articles/>
2. <https://www.interaction-design.org/literature>

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	2 (WK3, WK5)	2 (WK3, WK4, WK8)	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	1	2
CO2	3 (WK1, WK2, WK3, WK4)	3 (WK1, WK2, WK3, WK4)	2 (WK3, WK5)	2 (WK3, WK4, WK8)	2 (WK2, WK6)	–	–	–	–	–	1 (WK8)	2	1	2
CO3	3 (WK1, WK2, WK3, WK4)	3 (WK1, WK2, WK3, WK4)	3 (WK3, WK5)	3 (WK3, WK4, WK8)	3 (WK2, WK6)	–	–	–	–	–	–	3	2	3
CO4	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	3 (WK3, WK5)	3 (WK3, WK4, WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	2	3

Course Code :		BUEB604E	Full Stack Development	Semester :	06
L:T:P :		2:0:2		Course Type :	PEC
Hours/Sem.	Teaching :	28+26= 54 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	28		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Design and implement end-to-end web applications using contemporary full-stack technologies by integrating user interfaces, server-side programming, databases, APIs, authentication mechanisms, and deployment tools

After completion of the course, student will be able to:

- CO1:** Apply Javascript to build dynamic and interactive Web projects .
- CO2:** Implement user interface components for JavaScript-based Web using React.JS
- CO3:** Apply Express/Node to build web applications on the server side.
- CO4:** Develop data model in an open source nosql database and demonstrate modularization and packing of the front-end modules.

Unit-I

10 Hrs.

Introduction: Basic JavaScript Instructions, Statements, Comments, Variables, Data Types, Arrays, Strings, Functions, Methods & Objects, Decisions & Loops.**Document Object Model:** DOM Manipulation, Selecting Elements, Working with DOM Nodes, Updating Element Content & Attributes, Events, Different Types of Events, How to Bind an Event to an Element, Event Delegation, Event Listeners.

Unit-II

11 Hrs.

Form enhancement and validation. **Introduction to MERN:** MERN components, Server less Hello world. **React Components:** Issue Tracker, React Classes, Composing Components, Passing Data Using Properties, Passing Data Using Children, Dynamic Composition.

Unit-III

10 Hrs.

React State: Initial State, Async State Initialization, Updating State, Lifting State Up, Event Handling, Stateless Components, Designing Components, State vs. Props, Component Hierarchy, Communication, Stateless Components. **Express and GraphQL:** Express, REST API, GraphQL, Field Specification, Graph Based, Single Endpoint, Strongly Typed, Introspection, Libraries, The About API GraphQL Schema File, The List API, List API Integration, Custom Scalar types, The Create API, Create API Integration, Query Variables, Input Validations, Displaying Errors.

Unit-IV

11 Hrs.

MongoDB: Basics, Documents, Collections, Databases, Query Language, Installation, The Mongo Shell, **MongoDB CRUD Operations:** Create, Read, Projection, Update, Delete, Aggregate, **MongoDB Node.js Driver:** Schema Initialization, Reading from MongoDB, Writing to MongoDB. **Modularization and Webpack:** Back-End Modules Front-End Modules and Webpack Transform and Bundle, Libraries Bundle ,Hot Module Replacement, Debugging DefinePlugin: Build Configuration, Production Optimization.

List of Experiments

1.
 - a. Write a script that Logs "Hello, World!" to the console. Create a script that calculates the sum of two numbers and displays the result in an alert box.
 - b. Create an array of 5 cities and perform the following operations: Log the total number of cities. Add a new city at the end. Remove the first city. Find and log the index of a specific city.
2.
 - a. Read a string from the user, Find its length. Extract the word "JavaScript" using substring() or slice(). Replace one word with another word and log the new string. Write a function isPalindrome(str) that checks if a given string is a palindrome (reads the same backward).
3. Create an object student with properties: name (string), grade (number), subjects (array), displayInfo() (method to log the student's details) Write a script to dynamically add a passed property to the student object, with a value of true or false based on their grade. Create a loop to log all keys and values of the student object.
4. Create a button in your HTML with the text "Click Me". Add an event listener to log "Button clicked!" to the console when the button is clicked. Select an image and add a mouseover event listener to change its border color. Add an event listener to the document that logs the key pressed by the user.
5. Build a React application to track issues. Display a list of issues (use static data). Each issue should have a title, description, and status (e.g., Open/Closed). Render the list using a functional component.
6. Create a component Counter with A state variable count initialized to 0. Create Buttons to increment and decrement the count. Simulate fetching initial data for the Counter component using useEffect (functional component) or componentDidMount (class component). Extend the Counter component to Double the count value when a button is clicked. Reset the count to 0 using another button.
7. Install Express (npm install express). Set up a basic server that responds with "Hello, Express!" at the root endpoint (GET /). Create a REST API. Implement endpoints for a Product resource: GET : Returns a list of products. POST : Adds a new product. GET /:id: Returns details of a specific product. PUT /:id: Updates an existing product. DELETE /:id: Deletes a product. Add middleware to log requests to the console. Use express.json() to parse incoming JSON payloads.
8. 8. Install the MongoDB driver for Node.js. Create a Node.js script to connect to the shop database. Implement insert, find, update, and delete operations using the Node.js MongoDB driver. Define a product schema using Mongoose. Insert data into the products collection using Mongoose. Create an Express API with a /products endpoint to fetch all products. Use fetch in React to call the /products endpoint and display the list of products. Add a POST /products endpoint in Express to insert a new product. Update the Product List, After adding a product, update the list of products displayed in React

Reference Books:

1. Jon Duckett, "JavaScript & jQuery: Interactive Front-End Web Development", Wiley, 2014.
2. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node. Apress, 2019.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	3 (WK5)	1 (WK4, WK8)	3 (WK5, WK6)	1 (WK7)	–	1 (WK7)	1 (WK6)	2 (WK8)	–	3	2	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK4, WK8)	3 (WK5, WK6)	1 (WK7)	–	1 (WK7)	1 (WK6)	2 (WK8)	1 (WK6)	3	3	3
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK4, WK8)	3 (WK5, WK6)	1 (WK7)	–	2 (WK7)	2 (WK6)	2 (WK8)	1 (WK6, WK8)	3	3	3
CO4	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK4, WK8)	3 (WK5, WK6)	2 (WK7)	–	2 (WK7)	2 (WK6)	2 (WK8)	2 (WK6, WK8)	3	3	3

Course Code :		BUEC604E	Unix Shell Programming	Semester :	06
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Proficiency in navigating the UNIX operating system, managing file systems, and developing automated solutions using shell scripting and advanced text-processing tools (AWK and Perl) to streamline software development and system administration tasks.

Course Outcomes:

After completion of the course, student will be able to:

- CO1** : Understand the core UNIX architecture, navigate the UNIX file system, manage basic file attributes, and utilize the vi editor for text manipulation.
- CO2** : Analyze shell behavior and process management, customize the user environment, and implement simple text filters along with extended file attributes.
- CO3** : Apply regular expressions for advanced text filtering and construct essential shell scripts to automate system tasks.
- CO4** : Develop advanced text processing and data manipulation scripts using the awk and perl programming tools.

Unit-I

10 Hrs.

The Unix Operating System, The UNIX Architecture and Command Usage, The File System, Basic File Attributes, The vi Editor.

Unit-II

11 Hrs.

The Shell, The Process, Customizing the Environment, More File Attributes, Simple Filters.

Unit-III

10 Hrs.

Filters using Regular Expressions, Essential Shell Programming.

Unit-IV

11 Hrs.

awk – An Advanced Filter (awk Programming for Pattern Scanning and Data Processing)

perl - The Master Manipulator (Perl Programming for Text Processing and Automation)

Reference Books:

1. Sumitabha Das: "UNIX – Concepts and Applications", 4th Edition, 2006, Tata McGraw Hill.
2. Behrouz A. Forouzan, Richard F. Gilberg, "UNIX and Shell Programming", 2005, Cengage Learning.
3. M.G. Venkateshmurthy, "UNIX & Shell Programming", 2005, Pearson Education.

CO-PO Mapping:

Course Outcomes:	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	1 (WK3, WK4)	–	–	2 (WK6)	–	–	–	–	–	–	3	2	–
CO2	3 (WK3, WK4)	2 (WK3, WK4)	–	–	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	–
CO3	2 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	1 (WK8)	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	2
CO4	2 (WK3, WK4)	2 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3

Course Code :		BUED604E	Cyber Security	Semester :	06
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Understand the fundamental principles of cyber security, information security, and risk management to protect digital assets.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Describe the cybercrime terminologies.
- CO2:** Analyze cybercrime in mobiles and wireless devices along with the tools for cyber- crime and protection.
- CO3:** Analyze the motive and causes for cybercrime, cyber criminals and investigators.
- CO4:** Apply the methods for understanding criminal case and evidence, detection standing criminal case and evidence.

Unit-I

10 Hrs.

Introduction to Cybercrime: Cybercrime: Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals? Classifications of Cybercrimes, Cybercrime: The Legal Perspectives, Cybercrimes: An Indian Perspective, Cybercrime and the Indian ITA 2000. **Cyber offenses:** How Criminals Plan Them: Introduction, How Criminals Plan the Attacks.

Unit-II

11 Hrs.

Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Bot nets: The Fuel for Cybercrime, Attack Vector. Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Key loggers and Spywares.

Unit-III

10 Hrs.

Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, Attacks on Wireless Networks. **Understanding the people on the scene:** Introduction, understanding cyber criminals, understanding cyber victims, understanding cyber investigators.

Unit-IV

11 Hrs.

Understanding Cybercrime Prevention: Understanding Network Security Concepts, Understanding Basic Cryptography Concepts, Making the Most of Hardware and Software Security. Cybercrime Detection Techniques: Security Auditing and Log: Auditing for Windows platform, Firewall Logs, Reports, Alarms, and Alerts, Commercial Intrusion Detection Systems.

Reference Books:

1. Sunit Belapure, Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", 2013, Wiley India Pvt Ltd, ISBN: 978-81- 265-21791.
2. Debra Little, John Shinder, Michael Cross, "Scene of the cybercrime", 2nd Edition, 2008, Syngress publishing Inc, Elsevier Inc.

3. Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, 2016, O'Reilly Media, ISBN-13: 978-1491912058.
4. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, 2015, Wiley India Pvt Ltd, ISBN-13: 978-8126556014.
5. Wesley J Chun, "Core Python Applications Programming", 3rd Edition, 2015, Pearson Education India, ISBN-13: 978-9332555365.

CO-PO Mapping:

Course Outcomes:	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1 (WK1 WK2, WK3, WK4)	–	–	–	2 (WK2, WK6)	–	–	–	–	–	–	3	2	–
CO2	–	2 (WK3, WK4)	–	3 (WK3, WK4, WK8)	3 (WK2, WK6)	–	–	–	–	–	–	3	3	–
CO3	–	–	–	–	2 (WK2, WK6)	–	–	–	–	–	–	3	3	2
CO4	–	–	–	–	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3

Course Code :		BUEA631N	Virtual Instrumentation	Semester :	06
L:T:P :		3:0:0		Course Type :	OEC
Hours/Sem.	Teaching	: 42 Hrs.		CIE Marks	: 50
	Learning (TW+SL)	: 42 Hrs.		SEE Marks	: 50
	Exam	: 06 Hrs.		Total Marks	: 100
	Total Hrs.	: 90 Hrs.		Credits	: 03

Professional Competency:

Demonstrate the ability to design and implement virtual instrumentation systems using LabVIEW for data acquisition, monitoring, and control applications.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Acquire the knowledge of virtual instrumentation, LabVIEW environment, and its applications.
- CO2:** Explain and develop modular LabVIEW programs using subVIs, loops, and related programming concepts.
- CO3:** Apply arrays and programming structures for developing LabVIEW applications.
- CO4:** Understand and implement data acquisition and motion control concepts using LabVIEW. understanding criminal case and evidence, detection standing criminal case and evidence.

Unit-I

10 Hrs.

Virtual Instrumentation: Virtual instrument and traditional instrument, hardware and software in VI, VI for test, control and design, VI in engineering process, Text based programming and graphical programming. **Introduction to LabVIEW:** Advantages, software environment, creating and saving VI, front panel and block diagram tool bar, palettes, controls and indicators, block diagram, data types.

Unit-II

10 Hrs.

Modular Programming: Build a VI front panel and block diagram, building a connector pane, displaying SubVIs and express VIs, creating SubVIs, **Repetition and Loops:** For loops, while loops, structure tunnels, terminal inside or outside loops, shift registers, feedback nodes, control timing, communication among multiple loops.

Unit-III

11 Hrs.

Arrays: Creating one dimensional, two dimensional, multi-dimensional arrays, array initialization, deleting, inserting, replacing elements within an array, array function, auto indexing. **Structures:** Case, sequence, sequence structure, formula nodes, event structures.

Unit-IV

11 Hrs.

Data Acquisition: Signals, signal conditioning, DAQ hardware configuration, DAQ hardware, analog inputs, outputs, counters. **Motion Control:** Components, software for configuration, prototyping and development, motion controller, move types, motor amplifiers and drives.

Reference Books:

- Jerome, Jovitha, "Virtual instrumentation using LABVIEW", 1st Edition, 2010, PHI.
- Sanjay Gupta, Joseph John, "Virtual instrumentation using LABVIEW", 2nd Edition, 2017, MGH.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	1 (WK3, WK4)	–	–	2 (WK6)	–	–	–	–	–	–	3	2	–
CO2	3 (WK3, WK4)	2 (WK3, WK4)	2 (WK5)	–	3 (WK2, WK6)	–	–	–	–	–	–	3	3	–
CO3	3 (WK3, WK4)	3 (WK3, WK4)	2 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	–	3	3	1
CO4	3 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	2

Course Code :		BUEA605L	CMOS VLSI Laboratory	Semester :	06
L:T:P :		0:0:2		Course Type :	PCCL
Hours/Sem.	Teaching :	26 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	--		SEE Marks :	50
	Exam :	04 Hrs.		Total Marks :	100
	Total Hrs. :	30 Hrs.		Credits :	01

Professional Competency:

Demonstrate the ability to design, simulate, verify, and implement CMOS/TG-based digital circuits using VLSI design tools by performing schematic capture, layout design, DRC/LVS verification, RC extraction, and performance analysis.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Design CMOS/ TG based gates, MUX, flip flops, counters and shift register.
- CO2:** Draw layouts, perform DRC/ERC/LVS verification, and carry out DC, transient and post-layout analysis of CMOS circuits.
- CO3:** Design and simulate Transmission Gate (TG) based digital circuits for correct logical operation.
- CO4:** Design and verify sequential circuits such as shift registers and counters using EDA tools.

List of Experiments

Part - A: Full Custom IC Design Flow (Foundation)

For experiments 1 through 8, design the following CMOS circuits with the given specifications. Complete the VLSI design flow using the appropriate EDA tool:

- a) Draw the schematic and verify the design using DC and Transient Analysis.
 - b) Draw the layout and perform DRC and ERC verification.
 - c) Perform LVS verification.
 - d) Perform RC extraction and back-annotation, and verify the design.
1. Inverter
 2. Two-Input NAND Gate
 3. Two-Input NOR Gate
 4. Two-Input AND Gate
 5. Two-Input OR Gate
 6. Transmission Gate
 7. Two-Input XOR Gate
 8. Two-Input XNOR Gate

Part - B: Architectural Design and Simulation (Complex Systems)

For experiments 9 through 12, design the following circuits with the given specifications. Complete the front-end design flow using the appropriate EDA tool:

- a) Draw the schematic and verify the design using DC and Transient Analysis.
- Note: Layout and physical verification are not required for this section.
9. 2:1 Multiplexer (MUX)
 10. 4:1 Multiplexer (MUX)
 11. D- latch

12. D Flip-Flop
13. 3-Bit SISO Shift Register
14. 3-Bit Up Counter

Reference Books:

1. Neil H. E. Weste, David Harris "CMOS VLSI Design A Circuits and Systems Perspective", 4th Edition, 2015, Pearson Education Publisher.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits- A Design Perspective" 2nd Edition, 2010, Pearson Education Publisher.
3. John P. Uyemura "Introduction to VLSI Circuits and Systems", 2002, Wiley Publication.
4. R. Jacob Baker, Harry W. Li, David E. Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	2 (WK3, WK4)	3 (WK5)	–	3 (WK2, WK6)	–	–	–	–	–	–	3	2	3
CO2	3 (WK3, WK4)	3 (WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	–	–	–	–	3	3	3
CO3	3 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	3
CO4	3 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3

Course Code		:	BHSA600C	Indian Knowledge System	Semester	:	06
L:T:P		:	1:0:0		Course Type	:	AEC
Hours/Sem.	Teaching	:	14Hrs		CIE Marks	:	50
	Learning (TW+SL)	:	13Hrs		SEE Marks	:	50
	Exam	:	03Hrs		Total Marks	:	100
	Total Hrs.	:	30Hrs		Credit	:	01

Professional Competency:

Apply the principles of the Indian Knowledge System to appreciate, preserve, and utilize traditional knowledge for addressing contemporary societal and professional challenges.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Provide an overview of the concept of the Indian Knowledge System and its importance

CO2: Appreciate the need and importance of protecting traditional knowledge.

CO3: Recognize the relevance of Traditional knowledge in different domains.

CO4: Establish the significance of Indian Knowledge systems in the contemporary world

Unit-I

03Hrs.

Indian Knowledge Systems (IKS)

Overview, Vedic Corpus, Philosophy in Indian Knowledge system.

Unit-II

04Hrs.

Traditional Knowledge in Mathematics

Introduction to Indian Mathematics, Unique aspects of Indian Mathematics, Indian Mathematicians and their contribution. Number Systems and Units of Measurement.

Unit-III

04Hrs.

Traditional Knowledge in Science

Measurements for time, distance and weight, Astronomy, Indian contributions in astronomy, Astrology, The celestial coordinate system, Elements of the Indian calendar, Notion of years and month, Panchanga – The Indian calendar system

Unit-IV

04Hrs.

Traditional Knowledge in Professional domain

Town Planning and Architecture, Agriculture, Governance and Public Administration

Text Books:

1. Mahadevan. B. Bhat Vinayak Rajat, Nagendra Pavana R.N. "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi (2022). Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi

Reference Books:

1. Sampad and Vijay "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry. (2011).
2. Acarya. P.K. Indian Architecture, MunshiramManoharlal Publishers, New Delhi. (1996).
3. Kapoor Kapil, Singh Avadhesh "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P. (2021).
4. Dasgupta, S. A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi. (1975).
5. PLofer. K. (1963). Mathematics in India, Princeton University Press, New Jersey, USA"

Web Links and Video Lectures:

1. <https://www.youtube.com/watch?v=LZP1StpYEPm>
2. <http://nptel.ac.in/courses/121106003/>
3. <http://www.iitkgp.ac.in/departments/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63>
(Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5. https://unctad.org/system/files/official-document/ditcted10_en.pdf
6. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
development goals/?gclid=EAIaIQobChMInpJtb_p8gIVTeN3Ch2
7. <https://unfoundation.org/what-we-do/issues/sustainable>
developmentgoals/?gclid=EAIaIQobChMInp-

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2 (WK3, WK4)	2 (WK3, WK4)	–	1 (WK4)		2 (WK7)	1 (WK8)	3 (WK9)	–	2 (WK8)	2 (WK8)	3	2	3
CO2	2 (WK3, WK4)	2 (WK3, WK4)	1 (WK3, WK8)	–	1 (WK2, WK6)	3 (WK7)	2 (WK8)	3 (WK9)	–	1 (WK8)	2(WK8)	3	3	3
CO3	2 (WK3, WK4)	2 (WK3, WK4)	1 (WK3, WK8)	–	1 (WK2, WK6)	3 (WK7)	3 (WK8)	3 (WK9)	1 (WK8)	2 (WK8)	3 (WK8)	3	3	3
CO4	2 (WK3, WK4)	2 (WK3, WK4)	–	–	–	2 (WK7)	2 (WK8)	3 (WK9)	–	2 (WK8)	2 (WK8)	3	3	3

Seventh semester Syllabus

Course Code :		BHSA711C	Research Methodology and IPR	Semester :	07
L:T:P :		3:0:0		Course Type :	HSMC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Develop the ability to conduct ethical, systematic research and protect innovations through effective application of Intellectual Property Rights (IPR) principles.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Integrate research methodology in engineering sciences in relevant trades.
- CO2:** Exhibit reflective thinking in problem solving exercises.
- CO3:** Identify criteria to fit one's own intellectual work in particular form of IPRs.
- CO4:** Develop skill of making search using modern tools and techniques and become patent agent through patent agent exam.

Unit-I

10 Hrs.

Introduction to Engineering Research: Fundamentals of Research: Meaning, objectives, and motivation in engineering research. **Types of Engineering Research:** Basic, applied, and translational research; identifying and solving Worthwhile problems. **Research Ethics:** Ethics in engineering research and practice, types of research misconduct, and ethical issues in authorship...

Unit-II

10 Hrs.

Literature Review and Citations: Technical Reading & Analysis: Methods for reviewing literature, analyzing prior art, and synthesizing new and existing knowledge. **Bibliographic Databases:** Web of Science, Google, Google Scholar, effective search strategies. **Conceptualizing Research:** Critical and creative reading, taking notes, reading mathematical models, algorithms, and datasheets. **Citations & Acknowledgments:** Attribution, citation styles, impact of keywords, citing datasets, and knowledge dissemination.

Unit-III

10 Hrs.

Fundamentals of Intellectual Property Rights and Patents: Introduction to Intellectual Property Rights (IPR): Concept, nature, and significance of Intellectual Property, **Types of Intellectual Property:** Patents, Copyrights, Trademarks, Industrial Designs, Geographical Indications, Trade Secrets, and Plant Varieties. **Role of IPR in innovation:** research, entrepreneurship, and economic development. **International IPR Framework:** Overview of WIPO, WTO, TRIPS Agreement, Paris Convention, and Berne Convention. **Patents:** Meaning, objectives, and characteristics of patents. Patentable and non-patentable inventions. **Criteria for patentability:** Novelty, Inventive Step, and Industrial Applicability. **Patent search:** Importance and databases (InPASS, PATENTSCOPE, Google Patents). **Patent filing procedure in India:** Provisional and Complete Specifications. Patent examination, publication, opposition, grant, renewal, and infringement.

Copyrights, Trademarks, Industrial Designs and IPR Management: **Copyrights:** Meaning, subject matter, ownership, duration, and infringement, Copyright issues in the digital environment and academic research. **Trademarks and Industrial Designs:** Concept and importance of trademarks. Registration process, infringement, and remedies. **Industrial Designs:** Registration, protection, and significance. **Geographical Indications and Trade Secrets:** Concept, registration, and protection of Geographical Indications. Trade secrets and confidential information. **IPR Management and Commercialization:** Technology Transfer and Licensing. Patent valuation and commercialization. Intellectual Property in Start-ups and Academic Institutions. **Case studies on IPR disputes and emerging challenges in Artificial Intelligence and Digital Technologies.**

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, CasestudyofBasmatipatent. **IP Organizations In India. Schemes and Programmes.**

Reference Books:

1. Dr.Nejakar SantoshM, Dr.Bendigeri Harish (2023-24) "ResearchMethodology andIntellectualPropertyRights", ISBN978-93-5987-928-4,
2. Thiel DavidV., "ResearchMethodsforEngineers", CambridgeUniversityPress,
3. Acharya N.K., "IntellectualPropertyRights", 6th Edition, AsiaLawHouse.
4. P. Naryan, "Intellectual Property Law", 3rd Edition, 2007, Eastern Law House.
5. Dr. Myneni S. R., "Law of Intellectual Property", 9th Edition, 2019, Asia law House.
6. Dr. Reddy G.B, "Intellectual Property Rights and Law", Reprint Edition, 2020, Gogia Law Agency, Hyderabad.
7. N.R. Subbaram, S. Viswanathan, "Hand book Indian Patent Law and, Practice", 2008, Printers and Publishers Pvt. Ltd.
8. Cornish, "Intellectual Property Rights", Universal Publications.

Web Links and Video Lectures (e-Resources):

1. https://mooc.utm.my/courses/researchmethodologyforen?utm_source=chatgpt.com
2. https://arxiv.org/abs/physics/0601009?utm_source=chatgpt.com
3. https://scholar.google.com/?utm_source=chatgpt.com
4. https://www.webofscience.com/?utm_source=chatgpt.com
5. https://www.wipo.int/en/web/wipo-academy/programs/ip-elearning?utm_source=chatgpt.com
6. https://ipindia.gov.in/?utm_source=chatgpt.com
7. https://patentscope.wipo.int/?utm_source=chatgpt.com
8. https://patents.google.com/?utm_source=chatgpt.com
9. https://nptel.ac.in/courses/109106148?utm_source=chatgpt.com

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	–	2 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	1 (WK8)	2 (WK7)	3 (WK8)	–	1 (WK8)	2 (WK8)	1	–	–
CO2	–	3 (WK3, WK4)	3 (WK5)	–	3 (WK2, WK6)	2 (WK8)	2 (WK7)	2 (WK8)	–	–	2 (WK8)	2	–	–
CO3	–	–	–	2 (WK8)	3 (WK2, WK6)	3 (WK8)	2 (WK7)	3 (WK8)	–	1 (WK8)	3 (WK8)	1	–	–
CO4	–	–	2 (WK5)	3 (WK8)	3 (WK2, WK6)	2 (WK8)	–	1 (WK8)	–	1 (WK8)	–	2	–	–

Course Code		:	BUEA702C	Big Data Analysis	Semester	:	07
L:T:P		:	3:0:0		Course Type	:	PCC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Develop the ability to analyze, process, and visualize large-scale datasets using modern big data technologies to support data-driven decision-making and intelligent business solutions.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Understand the fundamentals of big data analysis and Hadoop.
- CO2:** Demonstrate the use of Hadoop and NoSQL.
- CO3:** Use MongoDB, Cassandra and MapReduce technologies for big data analysis
- CO4:** Exhibit the ability to use algorithms for data analysis and text, web content, link, and Social network analytics.

Unit-I

10 Hrs.

Introduction to Big Data Analytics: Big data, Scalability and parallel processing, Designing data architecture, Data sources, Quality, Pre-processing and storing, Data storage and analysis, Big data analytics Applications and case studies. **Introduction to Hadoop:** Introduction, Hadoop and its ecosystem, Hadoop distributed file system, MapReduce framework and programming model, Hadoop yarn, Hadoop ecosystem tools.

Unit-II

11 Hrs.

Hadoop Distributed File System Basics: HDFS design features, Components, HDFS user commands. **Essential Hadoop Tools:** Using Apache Pig, Hive, Sqoop, Flume, Oozie, HBase. **NoSQL Big Data Management:** Introduction, NoSQL data store, NoSQL data architecture patterns, NoSQL to manage big data, Shared-Nothing architecture for big data tasks.

Unit-III

11 Hrs.

MongoDB and Cassandra: MongoDB, Databases, Cassandra Databases. **Introduction to MapReduce:** Introduction, MapReduce map tasks, Reduce tasks and MapReduce execution, Composing MapReduce for calculations and algorithms, Hive, HiveQL, Pig. **Machine Learning Algorithms for Big Data Analytics:** Introduction, Estimating the relationships, Outliers, Variances, Probability distributions, and correlations.

Unit-IV

10 Hrs.

Algorithms for Big Data Analytics: Regression analysis, Finding similar items, Similarity of sets and collaborative filtering, Frequent item sets and association rule mining. **Text, Web Content, Link, and Social Network Analytics:** Introduction, Text mining, Web mining, Web content and web usage Analytics, Page rank, Structure of web and analyzing a web graph, Social network as graphs and Social network analytics.

Reference Books:

1. Raj Kamal and Preeti Saxena, "Big Data Analytics: Hadoop, Spark, and Machine Learning," 2018, McGraw Hill Education, ISBN: 9789353164966, 9353164966.
2. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem," 1st Edition, 2016, Pearson Education, ISBN-13: 978-9332570351.
3. Tom White, "Hadoop: The Definitive Guide," 4th Edition, 2015, O'Reilly Media, ISBN-13: 978-9352130672.
4. Boris Lublinsky, Kevin T Smith, Alexey Yakubovich, "Professional Hadoop Solutions," 1st Edition, 2014, Wrox Press, ISBN-13: 978-8126551071.
5. Eric Sammer, "Hadoop Operations: A Guide for Developers and Administrators," 1st Edition, 2012, O'Reilly Media, ISBN-13: 978-9350239261.
6. Arshdeep Bahga, Vijay Madiseti, "Big Data Analytics: A Hands-On Approach", 1st Edition, 2018, VPT Publications, ISBN-13: 978-0996025577.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK 3, WK 4)	2 (WK3 , WK4)	1 (WK 5)	2 (WK 8)	–	–	–	–	–	–	1 (WK 8)	3	1	2
CO2	3 (WK 3, WK 4)	3 (WK3 , WK4)	2 (WK 5)	2 (WK 8)	–	–	–	–	–	–	1 (WK 8)	2	1	2
CO3	3 (WK 3, WK 4)	3 (WK3 , WK4)	3 (WK 5)	3 (WK 8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK 3, WK 4)	2 (WK3 , WK4)	2 (WK 5)	3 (WK 8)	–	–	–	–	–	–	2 (WK 8)	3	2	3

Course Code :		BUEA703C	Computer Networks	Semester :	07
L:T:P :		2:0:2		Course Type :	IPCC
Hours/Sem.	Teaching :	28+26=54 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	28		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Design, analyze, configure, and evaluate computer networks by applying networking principles, communication protocols, and modern networking tools to develop reliable, secure, and efficient communication systems.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the terminology and concepts of the OSI reference model and the TCP/IP reference model.
- CO2:** Master the concepts of protocols, network interfaces, and design/performance issues in local area networks and wide area networks.
- CO3:** Identify, compare and contrast different techniques and design issues of core functions such as addressing, routing, internetworking, switching, multiplexing, error and flow control, medium access and coding.
- CO4:** Familiarize with widely- used Internet protocols such as TCP/IP, UDP and DNS in the Internet.

Unit-I

07 Hrs.

Layered tasks, OSI Model, Layers in OSI model, TCP/IP Suite, Addressing, Data Link Control: Framing, Flow and error control, Protocols, Noiseless channels and noisy channels, HDLC, PPP.

Unit-II

07 Hrs.

Multiple Accesses: Random access, Controlled access, Channelization, Wired LAN, Ethernet, IEEE standards, Standard Ethernet. Changes in the standards, Fast Ethernet, Gigabit Ethernet, Connecting LANs, Backbone and Virtual LANs.

Unit-III

07 Hrs.

Network Layer, Logical addressing, Ipv4 addresses, Ipv6 addresses, Ipv4 and Ipv6 Transition from Ipv4 to Ipv6, Delivery, Forwarding, Unicast Routing Protocols, Multicast Routing protocols.

Unit-IV

07 Hrs.

Transport layer Process to process Delivery, UDP, TCP, Application Layer: Domain name system, Name Space, Domain Name Space, Distribution of Name Space, DNS in the Internet, Resolution, DNS messages, Types of Records, Registrars, Dynamic Domain Name System, Encapsulation.

List of Experiments

1. Connecting Computers on LAN.
2. Study of packet tracer.
3. Configuration of different network topologies using packet tracer.
4. Configuration of switches and establishing LAN using packet tracer.
5. Creation of Virtual LAN using packet tracer.

6. Configuration of basic routing using packet tracer.
7. Configuration of a network using Routing Information Protocol (RIP) using packet tracer.
8. Configuration of a network using Open Shortest Path First (OSPF) using packet tracer.
9. Configuration of DHCP using packet tracer.
10. Configuration of NAT using packet tracer.

Reference Books:

1. Behrouz A. Forouzan, "Data Communication and Networking", 4th Edition, 2006, TMH, India.
2. Andrew S. Tanenbaum, "Computer Networks", 2010, Prentice-Hall.
3. William Stallings, "Data and Computer Communications", 2007, Prentice-Hall.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	–	2 (WK2, WK6)	–	–	–	–	–	1 (WK4)	3	2	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	1 (WK8)	3 (WK2, WK6)	1 (WK7)	–	1	1	–	2 (WK4, WK6)	3	3	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	1 (WK5, WK7)	–	1	1	–	2 (WK4, WK8)	3	3	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3)	2 (WK5)	1 (WK8)	3 (WK2, WK6)	1 (WK7)	–	1	1	–	2 (WK4, WK6)	3	3	3

Course Code		:	BUEA704E	System Verilog	Semester	:	07
L:T:P		:	2:0:2		Course Type	:	PEC
Hours/Sem.	Teaching	:	28+26=54 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	28 Hrs.		SEE Marks	:	50
	Exam	:	08 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Design, model, verify, and validate digital hardware systems using System Verilog and modern Electronic Design Automation (EDA) tools by applying hardware design and verification methodologies to develop reliable and efficient digital solutions

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the principles and methodologies used in verifying the functionality of digital systems.
- CO2:** Apply the System Verilog concepts to verify the complex digital circuits and develop and implement constrained random test benches using System Verilog
- CO3:** Analyze verification quality using functional coverage metrics and implement cover groups
- CO4:** Analyze real-world verification scenarios and apply System Verilog methodologies

Unit-I

07 Hrs.

Introduction to System Verilog: System Verilog standards, Key System Verilog enhancements for hardware design. Advantages of System Verilog over Verilog. **Data Types:** Verilog data types, System Verilog data types, 2 - State Data types, Bit, byte, shortint, int, longint. 4 - State data types. Logic, Enumerated data types, User Defined data types, Struct data types, Strings, Packages, Type Conversion: Dynamic casting, Static Casting, Memories: Arrays, Dynamic Arrays, Multidimensional Arrays, Packed Arrays, Associative Arrays, Queues, Array Methods.

Unit-II

07 Hrs.

Connecting the Test Bench and Design: Separating the Test Bench and Design, The Interface Construct, Stimulus Timing, Interface Driving and Sampling, System Verilog Assertions. **Procedural Statements and Routines:** Procedural Statements, Tasks, Functions and Void Functions, Task and Function Overview, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values.

Unit-III

07 Hrs.

Randomization: Introduction, Randomization in System Verilog, Constraint Details, Solution Probabilities, Valid Constraints, InLine Constraints, Random Number Functions, Common Randomization Problems, Random Control, Random Number Generators

Unit-IV

07 Hrs.

Functional Coverage: Introduction, Coverage Types, Functional Coverage Strategies , Anatomy of a Cover Group, Triggering a Cover Group, Data Sampling, Cross Coverage, Coverage Options, Parameterized Cover Groups. **Complete Design Model Using System Verilog- Case Study:** System Verilog ATM Example, Data Abstraction, Interface Encapsulation, Design Top Level Squat, Receivers and Transmitters, Test Bench for ATM.

List of Experiments

1. Develop mux2x1 verilog code in design.sv and develop Test bench for mux2x1 in testbench.sv with different inputs at various times.
2. Write a program to demonstrate two-state and four-state data types.
3. Write a program to demonstrate push_front, pop_front, push_back and pop_back with respect to Queues.
4. Design a full adder using the interface construct to model inter-module communication.
5. Create a program to highlight the difference between rand and randc constructs in constrained randomization.
6. Build a 4-bit adder and verify its functionality using a structured verification environment.
7. Design a UART module using SystemVerilog: a. Develop the transmitter logic b. Implement the receiver logic c. Create a top-level testbench to verify UART operation
8. Design, simulate, and analyze functional coverage to ensure thorough verification of a given design.
9. Design and simulate a verification test that exercises multiple sequences.
10. Create and simulate a configurable Universal Verification Methodology (UVM) test environment.

Reference Books:

1. Chris Spear, "System Verilog for Verification – A guide to learning the Test bench language features", Springer Publications, 2nd Edition, 2010.
2. Stuart Sutherland, Simon Davidmann, Peter Flake, "System Verilog for Design- A guide to using System Verilog for Hardware Design and Modelling", 2nd Edition, 2006, Springer Publications,
3. Janick Bergeron, "Writing Test benches using System Verilog".
4. Doulos, "System Verilog Golden Reference Guide-A Concise Guide to System Verilog", IEEE Standard1800- 2009, Version 5.0, ISBN: 0-9547345-9-9, 2012.
5. SasanIman, Hansen Brown "Step-by-Step Functional Verification with System Verilog and OVM", 2008, Publishing Company, ISBN-13: 978-0-9816-5621-2.
6. Janick Bergeron, "Verification Methodology Manual".

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	1 (WK8)	2 (WK2, WK6)	–	–	–	–	–	1 (WK4)	3	2	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK4, WK6, WK8)	3	3	3
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK2, WK6)	–	–	1	1	–	2 (WK6, WK8)	3	3	3
CO4	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	3 (WK2, WK6)	1 (WK5, WK7)	–	1	1	–	2 (WK4, WK6, WK8)	3	3	3

Course Code :		BUEB704E	Block Chain Technology	Semester :	07
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Develop the ability to design, implement, and manage secure, decentralized blockchain-based applications using distributed ledger technologies and smart contracts.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain the blockchain terminologies with its applications.
- CO2:** Illustrate the working principles of blockchain and the smart contract lifecycle.
- CO3:** Demonstrate the principles and methodologies used in Bitcoin.
- CO4:** Explain various blockchain platforms and tools and make use of Hyperledger in blockchain application architecture.

Unit-I

10 Hrs.

Distributed systems, CAP theorem, Byzantine Generals problem, Consensus. The history of blockchain, Introduction to blockchain, Various technical definitions of blockchains, Generic elements of a blockchain, Features of a blockchain, Applications of blockchain technology, Tiers of blockchain technology, Consensus in blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.

Unit-II

11 Hrs.

Decentralization using blockchain, Methods of decentralization, Blockchain and full ecosystem decentralization, Smart contract, Decentralized organizations, Decentralized autonomous organizations, Decentralized autonomous corporations, Decentralized autonomous societies Decentralized applications, Platforms for decentralization. Cryptographic primitives: Symmetric cryptography, Asymmetric cryptography, Public and private keys, Hash functions: Compression of arbitrary messages into fixed length digest, Easy to compute, Pre-image resistance, Second pre-image resistance, Collision resistance, Message Digest (MD), Secure Hash Algorithms (SHAs), Merkle trees, Patricia trees, Distributed hash tables (DHTs), Digital signatures, Elliptic Curve Digital signature algorithm (ECDSA).

Unit-III

11 Hrs.

Bitcoin, Bitcoin definition, Transactions, The transaction life cycle, The transaction structure, Types of transaction, The structure of a block, The structure of a block header, The genesis block, The bitcoin network, Wallets, Smart Contracts-History, Definition, Ricardian contracts, Smart contract templates, Oracles, Smart Oracles, Deploying smart contracts on a blockchain, The DAO.

Unit-IV

10 Hrs.

Ethereum 101, Introduction, Ethereum clients and releases, The Ethereum stack, Ethereum blockchain, Currency (ETH and ETC), Forks, Gas, The consensus mechanism, The world state, Transactions, Contract creation transaction, Message call transaction, Elements of the Ethereum blockchain, Ethereum virtual

machine (EVM), Accounts, Block, Ether, Messages, Mining, The Ethereum network. Hands-on: Clients and wallets –Geth. Hyperledger, Hyperledger as a protocol, Fabric, Hyperledger Fabric, Sawtooth lake, Corda.

Reference Books:

1. Imran Bashir, “Mastring Blockchain”, 3rd Edition, 2020, Packt.
2. Andreas M., “Mastering Bitcoin: Programming the Open Blockchain”, 2017, O’Rielly.

Co-Po Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2(WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code		:	BUEC704E	Cloud Computing	Semester	:	07
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Develop the ability to design, deploy, and manage scalable, secure, and cost-effective cloud-based applications and services using modern cloud computing technologies.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Understand various platforms which use modern cloud computing systems.
- CO2:** Demonstrate the concepts of virtualization technologies along with the architectural models of cloud computing.
- CO3:** Describe the concept of cloud computing architecture and cloud security.
- CO4:** Understand how industries leverage various cloud technologies.

Unit-I

10 Hrs.

Introduction: Introduction, Cloud computing at a glance, Historical developments, Building cloud computing environments, Amazon Web Services (AWS), Google App Engine, Microsoft Azure, Hadoop, Force.com, Salesforce.com, Manjrasoft Aneka.

Unit-II

11 Hrs.

Virtualization: Introduction, Characteristics of virtualized, Environments taxonomy of virtualization techniques, Execution virtualization, Other types of virtualization, Virtualization and cloud computing, Pros and cons of virtualization, Technology examples.

Unit-III

10 Hrs.

Cloud Computing Architecture: Introduction, Cloud reference model, Types of clouds, Economics of the cloud, Open challenges. **Cloud Security:** Risks, Top concern for cloud users, privacy impact assessment, Trust, OS security, VM security, Security risks posed by shared images and management OS.

Unit-IV

11 Hrs.

Cloud Platforms in Industry: **Amazon Web Services:** Compute services, Storage services, Communication services, Additional services. **Google AppEngine:** Architecture and core concepts, Application life cycle, Cost model, Observations. **Cloud Applications:** Scientific applications, HealthCare - ECG analysis in the cloud, Biology - Gene expression data analysis for cancer diagnosis, Geo-science -Satellite image processing. Business and consumer applications - CRM and ERP, Social networking, Media applications.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, Thamrai Selvi, "Mastering Cloud Computing", Morgan Kaufmann.
2. Dan C. Marinescu, "Cloud Computing Theory and Practice", Morgan Kaufmann, 2013, Elsevier.
3. Toby Velte, Anthony Velte, "Cloud Computing: A Practical Approach", McGraw-Hill Osborne Media.

4. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud”, O'Reilly Publication.
5. John Rhoton, “Cloud Computing Explained: Implementation Handbook for Enterprises”, Recursive Press.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2(WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code :		BUED704E	Software Engineering and Project Management	Semester :	07
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching :	42 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	42 Hrs.		SEE Marks :	50
	Exam :	06 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Develop the ability to design, develop, test, and manage software projects by applying software engineering principles, project management practices, and industry standards to deliver high-quality software solutions.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Understand the activities involved in software engineering and analyze the role of various process models.
- CO2:** Explain the basics of object-oriented concepts and build a suitable class model using modeling techniques.
- CO3:** Describe various software testing methods and to understand the importance of Agile methodology and DevOps and illustrate the role of project planning and quality management in software development.
- CO4:** Understand the importance of activity planning and different planning models.

Unit-I

10 Hrs.

Software and Software Engineering: The nature of software, The unique nature of WebApps, Software engineering, The software process, The software engineering practice, The software myths, How it all starts. **Process Models:** A generic process model, Process assessment and improvement, Prescriptive process models, Waterfall model, Incremental process models, Evolutionary process models, Concurrent models, Specialized process models.

Unit-II

11 Hrs.

Multi-threaded Programming: Overview; Multithreading models; Thread Libraries; Threading issues. Process Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms; Multiple-processor scheduling; Thread scheduling. **Process Synchronization:** Synchronization: The critical section problem; Peterson's solution; Synchronization hardware; Semaphores; Classical problems of synchronization; Monitors, **Deadlocks:** Deadlocks; System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.

Unit-III

11 Hrs.

Memory Management: Memory management strategies: Background; Swapping; Contiguous memory allocation; Paging; Structure of page table; Segmentation, **Virtual Memory Management:** Background; Demand paging; Copy-on-write; Page replacement; Allocation of frames; Thrashing. **File System, Implementation of File System:** File system: File concept; Access methods; Directory structure; File system mounting; File sharing; Protection: Implementing File system: File system structure; File system implementation; Directory implementation; Allocation methods; Free space management.

Unit-IV	10 Hrs.
Secondary Storage Structures, Protection: Mass storage structures; Disk structure; Disk attachment; Disk scheduling; Disk management; Swap space management. Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of access matrix, Access control, Revocation of access rights, Capability- Based systems, Case Study: The Linux Operating System: Linux history; Design principles; Kernel modules; Process management; Scheduling; Memory Management; File systems, Input and output; Inter-process communication.	
Reference Books: 1. Roger S. Pressman, "Software Engineering-A Practitioners approach", 7th Edition, Tata McGraw Hill. 2. Bob Hughes, Mike Cotterell, Rajib Mall, "Software Project Management", 6th Edition, 2018, McGraw Hill Education. 3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Wiley India.	

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	2 (WK5)	–	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2(WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	3 (WK5)	2 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code :		BUEA705E	Data Analytics Using R	Semester :	07
L:T:P :		2:0:2		Course Type :	PEC
Hours/Sem.	Teaching :	28+26=54 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	28 Hrs.		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Develop the ability to analyze, visualize, and interpret data using R programming to extract meaningful insights and support data-driven decision-making.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Describe the structures of R Programming
- CO2:** Illustrate the basics of Data Preparation with real world examples
- CO3:** Apply the Graphical Packages of R for visualization
- CO4:** Apply various Statistical Analysis methods for data analytics.

Unit-I

07 Hrs.

Basics of R: Introducing R, Initiating R, Packages in R, Environments and Functions, Flow Controls, Loops, Basic Data Types in R, Vectors, Matrices and Arrays, Lists

Unit-II

07 Hrs.

Basics of R (Continued): Data Frames, Factors, Strings, Dates and Times, **Data Preparation:** Datasets, Importing and Exporting files, Accessing Databases, Data Cleaning and Transformation

Unit-III

07 Hrs.

Graphics using R: Exploratory Data Analysis, Main Graphical Packages, Pie Charts, Scatter Plots, Line Plots, Histograms, Box Plots, Bar Plots, Other Graphical packages

Unit-IV

07 Hrs.

Statistical Analysis using R: Basic Statistical Measures, Normal distribution, Binomial distribution, Correlation Analysis, Regression Analysis-Linear Regression Analysis of Variance

List of Experiments

1. Demonstrate the steps for installation of R and R Studio. Perform the following:
 - a) Assign different type of values to variables and display the type of variable. Assign different types such as Double, Integer, Logical, Complex and Character and understand the difference between each data type.
 - b) Demonstrate Arithmetic and Logical Operations with simple examples.
 - c) Demonstrate generation of sequences and creation of vectors.
 - d) Demonstrate Creation of Matrices
 - e) Demonstrate the Creation of Matrices from Vectors using Binding Function.

Demonstrate element extraction from vectors, matrices and arrays
2. Assess the Financial Statement of an Organization being supplied with 2 vectors of data: Monthly

Revenue and Monthly Expenses for the Financial Year. You can create your own sample data vector for this experiment) Calculate the following financial metrics:

- a. Profit for each month.
- b. Profit after tax for each month (Tax Rate is 30%).
- c. Profit margin for each month equals to profit after tax divided by revenue.
- d. Good Months – where the profit after tax was greater than the mean for the year.
- e. Bad Months – where the profit after tax was less than the mean for the year.
- f. The best month – where the profit after tax was max for the year.
- g. The worst month – where the profit after tax was min for the year.

Note:

- a. All Results need to be presented as vectors
- b. Results for Dollar values need to be calculated with \$0.01 precision, but need to be presented in Units of \$1000 (i.e 1k) with no decimal points
- c. Results for the profit margin ratio need to be presented in units of % with no decimal point.
- d. It is okay for tax to be negative for any given month (deferred tax asset)

Generate CSV file for the data.

3. Develop a program to create two 3 X 3 matrices A and B and perform the following operations

a) Transpose of the matrix b) addition c) subtraction d) multiplication

4. Develop a program to create two 3 X 3 matrices A and B and perform the following operations a)

Transpose of the matrix b) addition c) subtraction d) multiplication

5. Develop an R Program using functions to find all the prime numbers up to a specified number by the method of Sieve of Eratosthenes.

6. The built-in data set mammals contain data on body weight versus brain weight. Develop R commands to: a) Find the Pearson and Spearman correlation coefficients. Are they similar? b) Plot the data using the plot command. c) Plot the logarithm (log) of each variable and see if that makes a difference

7. Develop R program to create a Data Frame with following details and do the following operations.

Item code	Item category	Item price
1001	Electronics	700
1002	Desktop Supplies	300
1003	Office Supplies	350
1004	USB	400
1005	CD Drive	800

Subset the Data frame and display the details of only those items whose price is greater than or equal to 350.

Subset the Data frame and display only the items where the category is either “Office Supplies” or “Desktop Supplies”

Create another Data Frame called “item-details” with three different fields itemCode, ItemQtyonHand and ItemReorderLvl and merge the two frames

8. Let us use the built-in dataset air quality which has Daily air quality measurements in New York, May to September 1973. Develop R program to generate histogram by using appropriate arguments for the following statements.

- a) Assigning names, using the air quality data set.
- b) Change colors of the Histogram

c) Remove Axis and Add labels to Histogram

d) Change Axis limits of a Histogram

e) Add Density curve to the histogram

9. Design a data frame in R for storing about 20 employee details. Create a CSV file named “input.csv” that defines all the required information about the employee such as id, name, salary, start_date, dept. Import into R and do the following analysis.

Find the total number rows & columns b) Find the maximum salary c) Retrieve the details of the employee with maximum salary d) Retrieve all the employees working in the IT Department. e) Retrieve the employees in the IT Department whose salary is greater than 20000 and write these details into another file “output.csv”.

10. Using the built in dataset mtcars which is a popular dataset consisting of the design and fuel consumption patterns of 32 different automobiles. The data was extracted from the 1974 Motor Trend US magazine, and comprises fuel consumption and 10 aspects of automobile design and performance for 32 automobiles (1973-74 models). Format A data frame with 32 observations on 11 variables : [1] mpg Miles/(US) gallon, [2] cyl Number of cylinders [3] disp Displacement (cu.in.), [4] hp Gross horsepower [5] drat Rear axle ratio, [6] wt Weight (lb/1000) [7] qsec 1/4 mile time, [8] vs V/S, [9] am Transmission (0 = automatic, 1 = manual), [10] gear Number of forward gears, [11] carb Number of carburetors

Develop R program, to solve the following:

a) What is the total number of observations and variables in the dataset?

b) Find the car with the largest hp and the least hp using suitable functions

c) Plot histogram / density for each variable and determine whether continuous variables are normally distributed or not. If not, what is their skewness?

What is the average difference of gross horse power(hp) between automobiles with 3 and 4 number of cylinders(cyl)? Also determine the difference in their standard deviations. e) Which pair of variables has the highest Pearson correlation?

11. Demonstrate the progression of salary with years of experience using a suitable data set (You can create your own dataset). Plot the graph visualizing the best fit line on the plot of the given data points. Plot a curve of Actual Values vs. Predicted values to show their correlation and performance of the model. Interpret the meaning of the slope and y-intercept of the line with respect to the given data. Implement using lm function. Save the graphs and coefficients in files. Attach the predicted values of salaries as a new column to the original data set and save the data as a new CSV file.

Reference Books:

1. G. Sudhamathy, C. Jothi Venkateswaran, “R Programming: An Approach to Data Analytics”, 2019, MJP Publishers
2. W. N. Venables, D.M. Smith, R development core team, “An Introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics”, Version 3.0.1 (2013-05-16).
1. Cotton R., “Learning R: A Step by Step Function Guide to Data Analysis”, 1st Edition, O’Reilly Media Inc.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code :		BUEB705E	Robotics and Automation	Semester :	07
L:T:P :		2:0:2		Course Type :	PEC
Hours/Sem.	Teaching :	28+26= 54 Hrs.		CIE Marks :	50
	Learning (TW+SL) :	28 Hrs.		SEE Marks :	50
	Exam :	08 Hrs.		Total Marks :	100
	Total Hrs. :	90 Hrs.		Credits :	03

Professional Competency:

Design, program, and troubleshoot robotic systems for industrial and service applications.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Explain robot fundamentals, classification, anatomy and applications.
- CO2:** Apply coordinate transformations and kinematic analysis techniques to robotic manipulators.
- CO3:** Analyze robot actuators, sensors and dynamic behavior.
- CO4:** Describe robot control strategies, programming methods and emerging robotic technologies.

Unit-I

10 Hrs.

Fundamentals of Robotics: Introduction to Robotics: Definition, History and Evolution of Robots, Classification of Robots, Components of Robotic Systems, Robot Anatomy and Degrees of Freedom, Robot Configurations, Robot Workspace, Robot Applications in Manufacturing, Healthcare, Agriculture, and Service Industries, Robot Performance Parameters.

Unit-II

11 Hrs.

Robot Kinematics: Coordinate Systems and Transformations, Position and Orientation Representation, Homogeneous Transformation Matrices, Forward Kinematics, Denavit - Hartenberg (D-H) Representation, Inverse Kinematics Concept, Kinematic Analysis of Simple Manipulators, Jacobian Matrix and Velocity Analysis.

Unit-III

10 Hrs.

Robot Dynamics, Actuators and Sensors: Introduction to Robot Dynamics, Equations of Motion, Actuation Systems: Electric, Hydraulic and Pneumatic Drives, DC and Servo Motors, Stepper Motors, End Effectors and Grippers, Sensors in Robotics: Position, Velocity, Force/Torque, Proximity and Vision Sensors, Sensor Integration.

Unit-IV

11 Hrs.

Robot Control and Applications: Robot Control Systems, Open-loop and Closed-loop Control, PID Control Basics, Robot Programming Concepts, Programming Methods: Lead-through and Off-line Programming, Industrial Robot Applications, Mobile Robots, Collaborative Robots (Cobots), Autonomous Robots, Introduction to Artificial Intelligence in Robotics, Emerging Trends and Future Directions.

List of Experiments

1. Visualize the Denavit–Hartenberg (DH) parameters of a serial manipulator using RoboAnalyzer.
2. Perform forward kinematics of a robot manipulator for a given set of joint variables.
3. Determine inverse kinematics for a desired end-effector position and orientation.
4. Verify forward kinematics by comparing the computed end-effector pose with RoboAnalyzer

animation.

5. Generate and analyze a joint-space trajectory between two robot configurations.
6. Compute inverse dynamics to obtain the actuator torques for a specified robot motion.
7. Perform forward dynamics simulation of a manipulator using specified joint torques.
8. Simulate robot motion using the Virtual Robot module and observe the manipulator movement.
9. Study recursive inverse dynamics of a serial manipulator using the RoboAnalyzer module.
10. Study recursive forward dynamics and simulation using RoboAnalyzer and analyze the resulting joint

Reference Books:

1. S. K. Saha, "Introduction to Robotics", 3rd Edition, McGraw-Hill Education.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code :		BUEC705E	Cryptography and Network Security	Semester :	07
L:T:P :		3:0:0		Course Type :	PEC
Hours/Sem.	Teaching	: 42 Hrs.		CIE Marks :	50
	Learning (TW+SL)	: 42 Hrs.		SEE Marks :	50
	Exam	: 06 Hrs.		Total Marks :	100
	Total Hrs.	: 90 Hrs.		Credits :	03

Professional Competency:

Develop the ability to design and implement secure communication systems by applying cryptographic techniques and network security principles to protect data and information systems from cyber threats.

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Analyze different terminologies of cryptography.
- CO2:** Understand the block cipher principle and encryption standards.
- CO3:** Describe public key cryptosystem and key management techniques
- CO4:** Understand IP security architecture, summarize web security and system security concepts.

Unit-I

10 Hrs.

Introduction: OSI security architecture, Security attacks, Security services, Security mechanism, Model for network security. **Classical Encryption Techniques:** Symmetric cipher model, Substitution Techniques, Transposition techniques.

Unit-II

11 Hrs.

Block Ciphers, Data Encryption Standard and Advanced Encryption Standard: Simplified DES, Block cipher principles, DES, Differential and Linear cryptanalysis, Modes of operation. **AES:** Evaluation criteria for AES, AES Cipher-encryption, and Decryption, Data structure, Encryption round, Triple DES, Blowfish.

Unit-III

11 Hrs.

Public Key Cryptography and Key Management: Principles of public key Cryptosystem, RSA Algorithm, Key management, Diffie Hellman key exchange, Elliptic curve cryptography. **IP Security:** IP security overview, IP security architecture: Authentication, Header, Encapsulating security payload, Combining security association, Key management.

Unit-IV

10 Hrs.

Web Security: Web security considerations, Secure socket Layer (SSL) and Transport layer security (TLS), Secure electronic transaction (SET). **System Security:** Intruders, Viruses, and Threats.

Reference Book:

1. William Stallings, "Cryptography and Network Security Principles and Practice," 6th Edition, 2014, Pearson Education Inc., ISBN: 978-93-325-1877-3.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK2, WK3, WK4)	2 (WK2, WK3)	1 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4)	3	1	2
CO2	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	2 (WK5)	2 (WK8)	–	–	–	–	–	–	1 (WK4, WK6, WK8)	2	1	2
CO3	3 (WK2, WK3, WK4)	3 (WK2, WK3, WK4)	3 (WK5)	3 (WK8)	–	–	–	–	–	–	–	3	2	3
CO4	3 (WK2, WK3, WK4)	2 (WK2, WK3, WK4)	2 (WK5)	3 (WK8)	–	–	–	–	–	–	2 (WK4, WK6, WK8)	3	2	3

Course Code		:	BUEC705E	Compiler Design	Semester	:	07
L:T:P		:	3:0:0		Course Type	:	PEC
Hours/Sem.	Teaching	:	42 Hrs.		CIE Marks	:	50
	Learning (TW+SL)	:	42 Hrs.		SEE Marks	:	50
	Exam	:	06 Hrs.		Total Marks	:	100
	Total Hrs.	:	90 Hrs.		Credits	:	03

Professional Competency:

Demonstrate the ability to apply the principles of automata theory, syntax analysis, and translation schemas to design, analyze, implement, and optimize the various phases of a compiler for high-level programming languages

Course Outcomes:

After completion of the course, student will be able to:

- CO1:** Apply the principles to design and implement a lexical analyzer.
- CO2:** Analyze various grammar constructs and apply top-down and bottom-up parsing techniques to construct a syntax analyzer.
- CO3:** Evaluate syntax-directed definitions and analyze run-time storage allocation strategies for target code execution.
- CO4:** Generate intermediate representations of code and apply optimization techniques to design a simple code generator..

Unit-I

10 Hrs.

Introduction to Compilers : Language Processors, The Structure of a Compiler (Phases of a compiler), The Evolution of Programming Languages, The Science of Building a Compiler, Applications of Compiler Technology, Programming Language Basics. **Lexical Analysis**: The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, The Lexical-Analyzer Generator Lex, Finite Automata, From Regular Expressions to Automata.

Unit-II

11 Hrs.

Basic Parsing Techniques and Top-Down Parsing: The Role of the Parser, Context-Free Grammars, Writing a Grammar. **Top-Down Parsing**: Recursive-Descent Parsing, FIRST and FOLLOW, LL (1) Grammars, Non-recursive Predictive Parsing, Error Recovery in Predictive Parsing. **Bottom-Up Parsing**: Shift-Reduce Parsing, Introduction to LR Parsing: Simple LR (SLR). More Powerful LR Parsers: Canonical LR (1) Items, LALR Parsers. Using Ambiguous Grammars, The Parser Generator Yacc

Unit-III

1 Hrs.

Syntax-Directed Translation: Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax-Directed Translation, Syntax-Directed Translation Schemes. **Run-Time Environments**: Storage Organization, Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Introduction to Garbage Collection.

Unit-IV

10 Hrs.

Intermediate Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Translation of Expressions, Type Checking, Control Flow, Back-patching, Switch-Statements, Intermediate Code for Procedures. **Code Generation and Machine-Independent Optimization**: Issues in

the Design of a Code Generator, The Target Language, Addresses in the Target Code, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, A Simple Code Generator, Peephole Optimization. The Principal Sources of Optimization, Introduction to Data-Flow Analysis.

Reference Book:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools", 2nd Edition, Pearson Education. (Core text for all units)
2. Kenneth C. Loudon, "Compiler Construction Principles & Practice", Cengage Learning.
3. Santanu Chattopadhyay, "Compiler Design", PHI Learning.
4. Tremblay, Sorenson, *"The Theory and Practice of Compiler Writing"*.
5. Leland L. Beck, "System Software", 3rd Edition, Pearson Education.

CO-PO Mapping:

Course Outcomes	Programme Outcomes											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3 (WK3, WK4)	1 (WK3, WK4)	–	–	2 (WK6)	–	–	–	–	–	–	3	2	–
CO2	3 (WK3, WK4)	2 (WK3, WK4)	2 (WK5)	–	3 (WK2, WK6)	–	–	–	–	–	–	3	3	–
CO3	2 (WK3, WK4)	3 (WK3, WK4)	3 (WK5)	1 (WK8)	2 (WK2, WK6)	–	–	–	–	–	1 (WK8)	3	3	2
CO4	2 (WK3, WK4)	2 (WK3, WK4)	3 (WK5)	2 (WK8)	3 (WK2, WK6)	–	–	–	–	–	2 (WK8)	3	3	3