CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE ANDENGINEERING

SEMESTERS I to VIII

2020 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING

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Items	Board of Studies(BOS)	Academic Council(AC)
Date of Approval	20.11.2020	30.12.2020
	03.02.2021	17.02.2021
	24.11.2021	22.04.2022
	28.02.2023	20.03.2023

Sd/-

Head of Department

Chairman, Board of Studies

Sd/-

Principal

Chairman, Academic Council

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:

To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:

To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Vision and Mission of the Department

Vision:

To be a Centre of Excellence in Computer Science and Engineering providing quality education and research for the betterment of the society.

Mission:

To impart sound knowledge in theoretical and applied foundations of Computer Science and Engineering, and to train the students to solve real life issues to effectively define and shape life.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be successful professionals in Industries of core or interdisciplinary nature or entrepreneurs, demonstrating effective leadership and excellent team work.
2. Graduates will expand the horizon of knowledge through higher education or research, leading to self-directed professional development.
3. Graduates will demonstrate professional attitude and ethics while providing solutions in societal and environmental contexts.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

. Engineering Graduates will have the ability to:

1. Apply Algorithmic Principles, Programming Skills and Software Engineering Principles to design, develop and evaluate Software Systems of varying complexities.
2. Apply knowledge of System Integration to design and implement computer-based systems.
3. Solve real world and socially relevant problems with the knowledge in recent and advanced Computing Technologies.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

For the students admitted from 2020-21

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B. Tech Programme is placed in one of the nine categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Table 1: Credit distribution and the Knowledge Domains

Sl. No.	Category	Category Code	Total credits
1	Humanities and Social Sciences including Management Courses	HSC	5
2	Basic Science Courses	BSC	26
3	Engineering Science Courses	ESC	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	79
5	Programme Elective Courses	PEC	15
6	Open Elective Courses	OEC	3
7	Project Work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	---
9	Mandatory Student Activities (P/F)	MSA	2
	Total Mandatory Credits		**162**
	Value Added Courses (Optional) – Honours/Minor	VAC	20

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	***Total Credits***
Credits for Courses	17	21	22	22	23	23	15	17	**160**
Activity Points (Min.)	40				60				**100**
Credits for Activities	2								**2**
Total Credits									**162**
Value Added Courses (Optional) – Honours / Minor									**20**
Total Credits									**182**

SEMESTER I						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10A	Linear Algebra and Calculus	3-1-0	4	4
B 1/2	BSC	PH0U10A	Engineering Physics A	3-1-0	4	4
		CY0U10A	Engineering Chemistry	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10A	Life Skills	2-0-2	4	---
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
			TOTAL		**23/24**	**17**

SEMESTER II						
Slot	**Categor yCode**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U10B	Vector Calculus, Differential Equations and Transforms	3-1-0	4	4
B 1/2	BSC	PH0U10A	Engineering Physics A	3-1-0	4	4
		CY0U10A	Engineering Chemistry	3-1-0	4	4
C 1/2	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D 1/2	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and Electronics Engineering	4-0-0	4	4
E	HSC	HS0U10B	Professional Communication	2-0-2	4	---
F	ESC	ES0U10E	Programming in C	2-1-2	5	4
S 1/2	BSC	PH0U18A	Engineering Physics Lab	0-0-2	2	1
		CY0U18A	Engineering Chemistry Lab	0-0-2	2	1
T 1/2	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
			TOTAL		**28/29**	**21**

SEMESTER III						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20B	Discrete Mathematical Structures	3-1-0	4	4
B	PCC	CS1U20A	Data Structures	3-1-0	4	4
C	PCC	CS1U20B	Logic System Design	3-1-0	4	4
D	PCC	CS1U20C	Object Oriented Programming using Java	3-1-0	4	4
E 1/2	ESC	ES0U20A	Design and Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20A	Sustainable Engineering	2-0-0	2	---
S	PCC	CS1U28A	Data Structures Lab	0-0-3	3	2
T	PCC	CS1U28B	Object Oriented Programming Lab (in Java)	0-0-3	3	2
R/M	VAC		Remedial/Minor Course	3-1-0	4	4
			TOTAL		**26/30**	**22/26**

SEMESTER IV						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	BSC	MA0U20E	Graph Theory	3-1-0	4	4
B	PCC	CS1U20D	Computer Organization and Architecture	3-1-0	4	4
C	PCC	CS1U20E	Database Management Systems	3-1-0	4	4
D	PCC	CS1U20F	Operating Systems	3-1-0	4	4
E 1/2 F	ESC	ES0U20A	Design and Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
	MNC	NC0U20B	Constitution of India	2-0-0	2	---
S	PCC	CS1U28C	Digital Lab	0-0-3	3	2
T	PCC	CS1U28D	Operating Systems Lab	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/ Honours Course	3-1-0	4	4
TOTAL					**26/30**	**22/26**

SEMESTER V						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS1U30A	Formal Languages and Automata Theory	3-1-0	4	4
B	PCC	CS1U30B	Computer Networks	3-1-0	4	4
C	PCC	CS1U30C	System Software	3-1-0	4	4
D	PCC	CS1U30D	Microprocessors and Microcontrollers	3-1-0	4	4
E	PCC	CS1U30E	Management of Software Systems	3-0-0	3	3
F	MNC	NC0U30A	Disaster Management	2-0-0	2	---
S	PCC	CS1U38A	System Software and Microprocessors Lab	0-0-4	4	2
T	PCC	CS1U38B	Database Management Systems Lab	0-0-4	4	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0	4	4
			TOTAL		**27/31**	**23/27**

SEMESTER VI						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS1U30F	Compiler Design	3-1-0	4	4
B	PCC	CS1U30G	Computer Graphics and Image Processing	3-1-0	4	4
C	PCC	CS1U30H	Algorithm Analysis and Design	3-1-0	4	4
D	PEC	CS1UXXX	Programme Elective I	2-1-0	3	3
E	HSC	HS0U30A	Industrial Economics and Foreign Trade	3-0-0	3	3
F	PCC	CS1U30I	Comprehensive Course Work	1-0-0	1	1
S	PCC	CS1U38C	Networking Lab	0-0-3	3	2
T	PWS	CS1U39A	Mini Project	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0	4	4
			TOTAL		**25/29**	**23/27**

PROGRAMME ELECTIVE I

Slot	CategoryCode	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CS1U31A	Foundations of Machine Learning	2-1-0	3	3
		CS1U31B	Data Analytics	2-1-0	3	3
		CS1U31C	Foundations of Security in Computing	2-1-0	3	3
		CS1U31D	Automated Verification	2-1-0	3	3
		CS1U31E	Programming in Python	2-1-0	3	3
		CS1U31F	Advanced Data Communication	2-1-0	3	3

SEMESTER VII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS1U40A	Artificial Intelligence	2-1-0	3	3
B	PEC	CS1UXXX	Programme Elective II	2-1-0	3	3
C	OEC	CS0UXXX	Open Elective	2-1-0	3	3
D	MNC	NC0U40A	Industrial Safety Engineering	2-1-0	3	---
E	PCC	CS1U48A	Compiler Design Lab	0-0-3	3	2
T	PWS	CS1U49A	Seminar	0-0-3	3	2
U	PWS	CS1U49B	Project Phase I	0-0-6	6	2
R/ M/H	VAC		Remedial/Minor/Honours Course	0-1-6/ 3-1-0	7/4	4
			TOTAL		**24 (31/28)**	**15/19**

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Course	L-T-P	Hours	Credit
B	PEC	CS1U41A	Machine Learning	2-1-0	3	3
		CS1U41B	Cloud Computing	2-1-0	3	3
		CS1U41C	Security in Computing	2-1-0	3	3

		CS1U41D	Model Based Software Development	2-1-0	3	3
		CS1U41E	Web Programming	2-1-0	3	3
		CS1U41F	Natural Language Processing	2-1-0	3	3

OPEN ELECTIVE I

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	OEC	CS0U41A	Introduction to Mobile Computing	2-1-0	3	3
		CS0U41B	Introduction to Deep Learning	2-1-0	3	3
		CS0U41C	Computer Graphics	2-1-0	3	3
		CS0U41D	Python for Engineers	2-1-0	3	3
		CS0U41E	Object Oriented Concepts	2-1-0	3	3

SEMESTER VIII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS1U40B	Distributed Computing	2-1-0	3	3
B	PEC	CS1UXXX	Programme Elective III	2-1-0	3	3
C	PEC	CS1UXXX	Programme Elective IV	2-1-0	3	3
D	PEC	CS1UXXX	Programme Elective V	2-1-0	3	3
T	PCC	CS1U40C	Comprehensive Viva Voce	1-0-0	1	1
U	PWS	CS1U49C	Project Phase II	0-0-12	12	4
R/M/H	VAC		Remedial/Minor/Honours Course	0-1-6	7	4
			TOTAL		**25/32**	**17/21**

PROGRAMME ELECTIVE III

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
B	PEC	CS1U42A	Deep Learning	2-1-0	3	3
		CS1U42B	Programming Paradigms	2-1-0	3	3
		CS1U42C	Cryptography	2-1-0	3	3
		CS1U42D	Soft Computing	2-1-0	3	3
		CS1U42E	Fuzzy Set Theory and Application	2-1-0	3	3
		CS1U42F	Embedded Systems	2-1-0	3	3
		CS1U42G	Computer Vision	2-1-0	3	3

PROGRAMME ELECTIVE IV

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	PEC	CS1U43A	Formal Methods and Tools in Software Engineering	2-1-0	3	3
		CS1U43B	Client Server Architecture	2-1-0	3	3
		CS1U43C	Parallel Computing	2-1-0	3	3
		CS1U43D	Data Compression Techniques	2-1-0	3	3
		CS1U43F	Data Mining	2-1-0	3	3
		CS1U43G	Mobile Computing	2-1-0	3	3

PROGRAMME ELECTIVE V

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CS1U44A	High Performance Computing	2-1-0	3	3
		CS1U44B	Blockchain Technologies	2-1-0	3	3
		CS1U44C	Image Processing Technique	2-1-0	3	3
		CS1U44D	Internet of Things	2-1-0	3	3
		CS1U44E	Software Testing	2-1-0	3	3
		CS1U44F	Bioinformatics	2-1-0	3	3
		CS1U44G	Computational Linguistics	2-1-0	3	3

B.Tech (MINOR)

Semester	BUCKET I Specialization: SOFTWARE ENGINEERING				BUCKET II Specialization: MACHINE LEARNING				BUCKET III Specialization:NETWORKING			
	Course Number	Course	L-T- P	Credit	Course Number	Course	L-T- P	Credit	Course Number	Course	L-T- P	Credit
S3	CS0M20A	Object Oriented Programming	3 - 1- 0	4	CS0M20B	Python for Machine Learning	3-1-0	4	CS0M20C	Data Communication	3-1-0	4
S4	CS0M20D	Programming Methodologies	3 - 1- 0	4	CS0M20E	Mathematics for Machine Learning	3-1-0	4	CS0M20F	Introduction to Computer Networks	3-1-0	4
S5	CS0M30A	Concepts in Software Engineering	3 - 1- 0	4	CS0M30B	Concepts in Machine Learning	3-1-0	4	CS0M30C	Client Server Systems	3-1-0	4
S6	CS0M30D	Introduction to Software Testing	3 - 1- 0	4	CS0M30E	Concepts in Deep Learning	3-1-0	4	CS0M30F	Wireless Networks and IoT Applications	3-1-0	4
S7	CS0M49A	Mini Project	0-1-6	4	CS0M49A	Mini Project	0-1-6	4	CS0M49A	Mini Project	0-1-6	4

S8	CS0M49B	Mini Project	0-1-6	4	CS0M49B	Mini Project	0-1-6	4	CS0M49B	Mini Project	0-1-6	4

B. Tech (HONOURS)

Semester	BUCKET I Specialization: SECURITY IN COMPUTING				BUCKET II Specialization: MACHINE LEARNING				BUCKET III Specialization: FORMAL METHODS			
	Course Number	**Course**	**L-T- P**	**Credit**	**Course Number**	**Course**	**L-T- P**	**Credit**	**Course Number**	**Course**	**L-T- P**	**Credit**
S4	CS1H20A	Number Theory	3-1-0	4	CS1H20B	Computational Fundamentals of Machine Learning	3-1-0	4	CS1H20C	Principles of Program Analysis and Verification	3-1-0	4
S5	CS1H30A	Cryptographic Algorithms	3-1-0	4	CS1H30B	Neural Networks and Deep Learning	3-1-0	4	CS1H30C	Principles of Model Checking	3-1-0	4
S6	CS1H30D	Network Security	3-1-0	4	CS1H30E	Advanced Topics in Machine Learning	3-1-0	4	CS1H30F	Theory of Computability and Complexity	3-1-0	4
S7	CS1H40A	Cyber Forensics	3-1-0	4	CS1H40B	Advanced Topics in Artificial Intelligence	3-1-0	4	CS1H40C	Logic for Computer Science	3-1-0	4
S8	CS1H49A	Mini Project	0-1-6	4	CS1H49A	Mini Project	0-1-6	4	CS1H49A	Mini Project	0-1-6	4

SEMESTER I

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U10A	LINEAR ALGEBRA AND CALCULUS	BSC	3	1	0	4	2020

COURSE OVERVIEW:

This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analysing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analysing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

COURSE OUTCOMES

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

CO 1	Solve systems of linear equations.	Apply
CO 2	Compute maxima and minima using partial derivatives.	Evaluate
CO 3	Compute areas and volumes of geometrical shapes using multiple integrals.	Evaluate
CO 4	Identify the convergence or divergence of an infinite series.	Evaluate
CO 5	Determine the Taylor and Fourier series expansion of functions and learn their applications.	Apply

SYLLABUS

Basics of Linear Algebra – Solution of systems of linear equations, row echelon form, rank, eigen values and eigen vectors, diagonalization of matrices, orthogonal transformation, quadratic forms.
Partial Differentiation and Applications – Limit and continuity of functions of two or more variables, partial derivatives, chain rule, total derivatives, maxima and minima.

Multiple Integrals – Double and triple integrals, double integrals over rectangular and non-rectangular regions, changing the order of integration, finding areas and volume, mass and centre of gravity.

Infinite series - Convergence and divergence of Infinite series, geometric series and p-series, test of convergence, Alternating series, absolute and conditional convergence

Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions -Fourier Series- Euler's formulas, Fourier sine and cosine series, Half range expansions

TEXT BOOKS

1) H. Anton, I. Biven, S. Davis, *Calculus*, Wiley, 10^{th} Edition, 2015.
2) Erwin Kreyszig, *Advanced Engineering Mathematics,* John Wiley &Sons, 10^{th}Edition, 2016.

REFERENCES

1) J.Stewart, *Essential Calculus*,Cengage,2^{nd}Edition,2017.
2) G.B.Thomas and R.L.Finney, Calculus and Analytic geometry, 9^{th}Edition, Pearson, Reprint, 2002.

3) Peter V. O'Neil, *Advanced Engineering Mathematics*, Cengage, 7th Edition 2012.

COURSE PLAN

Module	Contents	No. of hours
I	Linear Algebra: Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and Eigen vectors. Diagonalization of matrices, orthogonal transformation, quadratic forms and their canonical forms.	12
II	Multivariable calculus-Differentiation: Concept of limit and continuity of functions of two variables, partial derivatives, Differentials, Local Linear approximations, chain rule, total derivative, Relative maxima and minima, Absolute maxima and minima on closed and bounded set.	12
III	Multivariable Calculus-Integration: Double integrals (Cartesian), reversing the order of integration, change of coordinates (Cartesian to polar), finding areas and volume using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).	12
IV	Sequences and Series: Convergence of sequences and series, convergence of geometric series and p-series(without proof), test of convergence (comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.	12
V	Series representation of functions: Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formulas, Convergence of Fourier series (without proof), half range sine and cosine series, Perceval's theorem (without proof).	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment/Project/Case study etc.	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U10A	ENGINEERING PHYSICS-A (FOR CIRCUIT BRANCHES)	BSC	3	1	0	4	2020

COURSE OVERVIEW:

The aim of the course is to develop scientific attitude in students and offer them an understanding of physical concepts behind various engineering applications. It creates an urge in students to think creatively in emerging areas of Physics.

COURSE OUTCOMES

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

CO 1	Describe the characteristics of different types of oscillations and waves.	Remember
CO 2	Apply the principles of wave optics to explain natural physical processes and related technological advances.	Understand
CO 3	Use the principles of quantum mechanics to analyses the behavior of matter in the atomic and subatomic level	Understand
CO 4	Apply the fundamental ideas of magnetism and vector calculus to arrive at Maxwell's equations.	Understand
CO 5	Describe the principles behind various superconducting applications, solid-state lighting devices and fiber optic communication system.	Apply

SYLLABUS

Oscillations and Waves: Damped oscillations, Forced oscillations, One dimensional and three-dimensional wave equations, Transverse vibrations along a stretched string

Wave Optics: Interference of light- Air wedge, Newton's rings, Antireflection coating, Diffraction-Fraunhofer diffraction at a single slit, Grating equation, Rayleigh's criterion

Quantum Mechanics & Nano technology: Wave function, Time dependent and time independent Schrodinger wave equations, One-dimensional potential well, Introduction to nanoscience and technology, Quantum confinement, Properties of nanomaterials

Magnetism & Electro Magnetic Theory: Magnetic field and Magnetic flux density, fundamental laws, magnetic permeability and susceptibility, classification of magnetic materials, fundamentals of vector calculus and theorems, equation of continuity, Maxwell's equations in vacuum, velocity of electromagnetic waves in free space.

Superconductivity & Photonics: Super conductivity- Meissner effect, Type I &II superconductors, applications of superconductors, Introduction to photonics-photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V characteristics, Optical fiber -Principle, Numerical aperture, Types of fibers, Applications

TEXT BOOKS

1) M.N. Avadhanulu, P.G. Kshirsagar, T.V. S Arun Murthy, *A Text book of Engineering Physics*, S.Chand&Co., Revised Edition, 2014

2) H.K. Malik, A.K. Singh, *Engineering Physics,* McGraw Hill Education, 2nd Edition, 2017

REFERENCES

1) Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw Hill Publications, 6thEdition, 2003.
2) Aruldhas G., *Engineering Physics*, Prentice Hall of India Pvt. Ltd., 2015
3) Ajoy Ghatak, *Optics*, Mc Graw Hill Education, 6th Edition, 2017
4) David J. Griffiths, *Introduction to Electrodynamics*, Pearson, 4thEdition, 2013.
5) Premlet B., *Advanced Engineering Physics*, Phasor Books,10thEdition,2017.

COURSE PLAN

Module	Contents	No. of hours
I	Oscillations and Waves: Harmonic oscillations, damped harmonic motion-derivation of differential equation and its solution, over damped, critically damped and under damped cases, Quality factor-expression, forced oscillations-differential equation-derivation of expressions for amplitude and phase of forced oscillations, amplitude resonance-expression for resonant frequency, Quality factor and sharpness of resonance, electrical analogy of mechanical oscillators Wave motion- derivation of one-dimensional wave equation and its solution, three-dimensional wave equation and its solution (no derivation), distinction between transverse and longitudinal waves, transverse vibration in a stretched string, statement of laws of vibration	12
II	Wave Optics: Interference of light-principle of superposition of waves, theory of thin films - cosine law (Reflected system), derivation of the conditions of constructive and destructive interference, interference due to wedge shaped films -determination of thickness and test for optical planeness, Newton's rings- measurement of wavelength and refractive index, antireflection coatings. Diffraction of light, Fresnel and Fraunhofer classes of diffraction, diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, resolving and dispersive power of a grating with expression (no derivation)	12
III	Quantum Mechanics & Nanotechnology: Introduction for the need of Quantum mechanics, wave nature of Particles, uncertainty principle, Applications-absence of electrons inside a nucleus and natural line broadening mechanism, formulation of time dependent and independent Schrodinger wave equations-physical meaning of wave function, Particle in a one dimensional box- derivation for normalised wave function and energy Eigen values, Quantum mechanical tunnelling (qualitative). Introduction to nanoscience and technology, increase in surface to volume ratio for nanomaterials, quantum confinement in one dimension, two dimension and three dimension-nano sheets, nano wires and quantum dots, properties of nanomaterials-mechanical, electrical and optical, applications of nanotechnology (qualitative ideas)	12
IV	Magnetism and Electromagnetic theory: Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux density, Ampere's Circuital law, Faraday's law in terms of emf produced by changing magnetic flux, Magnetic permeability and susceptibility, classification of magnetic materials-para, dia and ferromagnetic materials	12

	Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, line, surface and volume integrals, Gauss divergence theorem & Stokes' theorem, equation of continuity, derivation of Maxwell's equations in vacuum, comparison of displacement current with conduction current, electromagnetic waves, velocity of electromagnetic waves in free space, flow of energy and Poynting's vector (no derivation)	
V	Superconductivity &Photonics: Superconducting phenomena, Meissner effect and perfect diamagnetism, types of Superconductors-Type I and Type II, BCS Theory (Qualitative), high temperature superconductors-applications of super conductivity Introduction to photonics-photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V characteristics, Optic fibre-principle of propagation of light, types of fibres-step index and graded index fibres, numerical aperture –derivation, fibre optic communication system (block diagram), industrial, medical and technological applications of optical fibre, fibre optic sensors-intensity modulated and phase modulated sensors.	12
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10A	ENGINEERING MECHANICS	ESC	2	1	0	3	2020

COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies while stationary or in motion. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

COURSE OUTCOMES

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

CO 1	Explain the principles and theorems related to rigid body mechanics.	Understand
CO 2	Describe the components of system of forces acting on the rigid body.	Understand
CO 3	Apply the properties of distributed areas and masses for solving problems involving rigid bodies.	Apply
CO 4	Apply the conditions of equilibrium to various practical problems involving different force systems.	Apply
CO 5	Apply appropriate principles to solve problems in rigid body mechanics.	Apply

SYLLABUS

Statics of rigid bodies: Classification of force systems, Composition and resolution of forces, Resultant and equilibrium equations, Methods of projections, Varignon's Theorem of moments.

Friction: Analysis of single and connected bodies. Parallel coplanar forces, couple. Beam reactions.

Properties of surfaces: Centroid of composite areas, Moment of inertia of areas, Polar moment of inertia, Theorem of Pappus-Guldinus, Forces in space.

Dynamics: D'Alembert's principle, Motion on horizontal and inclined surfaces, Motion of connected bodies. Impulse momentum and work energy relation. Curvilinear translation.

Rotation: Kinematics of rotation. Plane motion of rigid body: Instantaneous centre. Simple harmonic motion: Mechanical vibrations.

TEXTBOOKS

1) Timoshenko, S., Young, D. H., Rao, J. V. and Pati, S., *Engineering Mechanics*, Mc-Graw Hill Publishers, 2017.
2) Beer, F. P. and Johnston, R., *Vector Mechanics for Engineers: Statics and Dynamics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 12thEdition, 2005.
3) Bansal, R. K., *A Textbook of Engineering Mechanics*, Laxmi Publications, 8thEdition, 2016.
4) Sharma, D. P., Hibbeler, R. C. and Shames, I. H., *Engineering Mechanics*, Pearson Publishers, 2011.

REFERENCES

1) Bhavikkatti, S. S., *Engineering Mechanics*, New Age International Publishers, 2016.
2) Merriam, J. L. and Kraige, L. G., *Engineering Mechanics* - Vols. 1 and 2, John Wiley, 7thEdition, 2006.
3) Hibbeler, R. C. and Gupta, A., *Engineering Mechanics*, Vol. I Statics, Vol II Dynamics, Pearson Education, 2009.
4) Shames, I. H., *Engineering Mechanics - Statics and Dynamics*, Prentice Hall of India,4th Edition 2005.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to engineering mechanics - Introduction on statics and dynamics - Basic principles of statics - Parallelogram law, Equilibrium law - Superposition and transmissibility, Law of action and reaction. Free body diagrams - Degree of Freedom-Types of supports and nature of reactions -Exercises for free body diagram preparation - Composition and resolution of forces, Resultant and equilibrium equations. Concurrent coplanar forces - Analysis of concurrent forces - Methods of projections - Methods of moment - Varignon's Theorem of Moments.	9
II	Friction - Sliding friction - Coulomb's laws of friction - Analysis of single bodies - Analysis of connected bodies. Parallel coplanar forces - Couple - Resultant of parallel forces - Centre of parallel forces - Equilibrium of parallel forces - Simple beam subject to concentrated vertical loads. General coplanar force system - Resultant and equilibrium equations.	9
III	Centroid of regular geometrical shapes - Centroid of Composite areas. Moment of inertia- Parallel axis theorem - Perpendicular axis theorem -Polar moment of inertia, Radius of gyration. Mass moment of inertia of ring, cylinder and uniform disc. Theorem of Pappus Guldinus. Introduction to forces in space -Vectorial representation of forces, moments and couples - Resultant and equilibrium equations for concurrent forces in space - Concurrent forces in space.	9
IV	Introduction to dynamics - Rectilinear translation - Equations of kinematics. Introduction to kinetics - Equation of motion - D'Alembert's principle - Motion on horizontal and inclined surfaces - Motion of connected bodies. Curvilinear translation - Projectile motion - Introduction to kinetics - equation of motion. Impulse momentum equation and work energy equation. Moment of momentum and work energy equation (Curvilinear translation).	9
V	Rotation - Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis - Rotation under a constant moment. Plane motion of rigid body- Instantaneous Centre of rotation (concept only).	9

	Introduction to harmonic oscillation - Free vibrations - Simple harmonic motion – Differential equation and solution. Degree of freedom - Examples of single degree of freedom (SDOF) systems -Idealisation of mechanical systems as spring-mass systems (concept only). SDOF spring mass system - Equation of motion –Undamped free vibration response - Concept of natural frequency. Effect of damping on free vibration response (concept only).	
	Total hours	45

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment/Quiz/Course project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10C	BASICS OF CIVIL AND MECHANICAL ENGINEERING	ESC	4	0	0	4	2020

COURSE OVERVIEW

The goal of this course is to provide an insight on the essentials of Civil and Mechanical Engineering discipline to the students of all branches of Engineering and to provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.

COURSE OUTCOMES

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

CO 1	Explain different types of buildings, their components, materials, construction techniques and basic infrastructure services.	Understand
CO 2	Describe the importance, objectives and principles of surveying.	Understand
CO 3	Apply the principles of levelling to find the level difference between points.	Apply
CO 4	Summarise the different materials and systems in the context of green buildings.	Understand
CO 5	Analyse thermodynamic cycles and Illustrate the working and features of IC Engines	Apply
CO 6	Explain the basic principles of Refrigeration and Air Conditioning and working of hydraulic machines	Understand
CO 7	Explain the working of power transmission elements, basic manufacturing, metal joining and machining processes	Understand

SYLLABUS

Introduction to Civil Engineering: Relevance and major disciplines of Civil Engineering, Introduction to buildings: Types and different components of buildings, building rules and regulations, Building area.

Introduction to surveying: Objectives, Principle, Classification, Levelling, Introduction to modern surveying instrument- Total Station.

Construction materials: Bricks, Stones, Sand, Timber, Cement, Cement mortar, Concrete, Steel, Modern construction materials.

Building construction: Foundations, Brick masonry, Roofs and floors, Basic infrastructure services, Green buildings.

Basics of Mechanical Engineering: Fundamental of thermodynamics. Analysis of thermodynamic cycles and working of internal combustion engines. CRDI, MPFI and concept of hybrid vehicles.

Refrigeration and power transmission systems - Analysis of reversed Carnot cycle and vapour compression cycle. Introduction to psychometric. Layout of unit and central air conditioner.

Description and basic analysis of hydraulic pump and turbine. Working of different power transmission devices.

Manufacturing methods and machine tools - Description of various manufacturing, metal joining process and basic machining operations.

Working of different machines tools and CNC machine. Introduction to CAD/CAM, additive and rapid manufacturing.

TEXT BOOKS

1) Mamlouk, M. S., and Zaniewski, J. P., *Materials for Civil and Construction Engineering*, Pearson Publishers, 4^{th} Edition, 2017.
2) Rangwala, S. C., *Essentials of Civil Engineering*, Charotar Publishing House, 1^{st} Edition, 2012.
3) Clifford, M., Simmons, K. and Shipway, P., *An Introduction to Mechanical Engineering Part I* - CRC Press, 2009.
4) Kumar, P., *Basic Mechanical Engineering*, Pearson India, 2013.

REFERENCES

1) Chen W. F. and Liew J. Y. R. (Eds), *The Civil Engineering Handbook*, CRC Press (Taylor and Francis), 2^{nd}Edition, 2002
2) Punmia B. C., Ashok, K. J. and Arun K. J., *Surveying*, Vol. I, Laxmi Publications (P) ltd., New Delhi, 17^{th}Edition, 2016
3) *Kerala Municipal Building Rules*, LSGD, Govt. of Kerala, 2019
4) SP 7: 2016*, National Building Code of India*, BIS, New Delhi, 2016.
5) Wylen G. J. V., Sonntag, R. and Borgnakke C., *Fundamentals of Classical Thermodynamics*, John Wiley & Sons,2012.
6) Sawhney G. S., *Fundamentals of Mechanical Engineering*, PHI Learning; 3^{rd} Revised Edition, 2015.

COURSE PLAN

Module	Contents	No. of hours
I	**General Introduction to Civil Engineering:** Relevance of Civil Engineering in the overall infrastructure development of the Country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Structural Engineering, Transportation Engineering, Geotechnical Engineering, Water Resources Engineering and Environmental Engineering. **Introduction to buildings:** Types of buildings, selection of site for buildings, components of a residential building and their functions. **Building rules and regulations:** Relevance of NBC, KBR & CRZ norms (brief discussion only). **Building area:** Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR. **Surveying:** Importance, classification, objectives and principles, instruments used. Levelling- principles, dumpy level, simple levelling, differential levelling- problems. Introduction to modern surveying instruments-Total Station.	10

II	**Construction materials:** Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand and timber. **Cement Mortar:** Materials and properties. **Cement concrete:** Constituent materials, properties and types. **Steel:** Steel sections and steel reinforcements, types and uses. **Modern construction materials:** Architectural glass, ceramics, plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre-fabricated building components (brief discussion only).	10
III	**Building Construction: Foundations:** Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only). **Brick masonry:** Header and stretcher bond, English bond and Flemish bond. **Roofs and floors:** Functions, types; flooring materials (brief discussion only). **Basic infrastructure services:** MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings. **Green buildings:** Materials, energy systems and water management and environment for green buildings (brief discussion only).	10
IV	**Fundamentals of thermodynamics**: Review of basics of thermodynamics-system, surroundings, process, cycle- quasistatic process, laws of thermodynamics. Analysis of thermodynamic cycles: Carnot, Otto, Diesel cycles, Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net-work and efficiency. **IC Engines**: CI, SI, 2- Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines. Efficiencies of IC Engines (Definitions only), Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines.	10
V	**Refrigeration**: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners. **Hydraulic machines**: Working principle of Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles) **Power Transmission Devices**: Belt and Chain drives, Gear and Gear trains, Single plate clutches.	10
VI	**Manufacturing Process**: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications. Metal Joining Processes: List types of welding, Description with sketches of Arc Welding, Soldering and Brazing and their applications. **Basic Machining Operations**: Turning, Drilling, Milling and Grinding. Lathe, drilling machine, Milling machine. **Computer Aided Machining**: CNC Machine. Principle of CAD/CAM, Rapid and Additive manufacturing.	10
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment/Quiz/Course project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10A	LIFE SKILLS	HSC	2	0	2	-	2020

COURSE OVERVIEW:
This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underly personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

COURSE OUTCOMES

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

CO 1	Identify different skills required in personal and professional life.	Understand
CO 2	Apply well defined techniques to cope with emotions and stress and to provide an awareness of the self.	Apply
CO 3	Apply appropriate thinking tools and techniques for creative problem solving.	Apply
CO 4	Explain the importance of teamwork, team performance and team conflicts.	Understand
CO 5	Explain the basic mechanics of effective communication and demonstrate these through presentations.	Understand

SYLLABUS

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO, Life skills for professionals, personality development, IQ, EQ, and SQ.

Self-awareness & Stress Management: Definition and need for self-awareness; Tools and techniques of SA, Stress, reasons and effects, the four A's of stress management, Techniques and Approaches, PATH method and relaxation techniques.

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, Leadership Grid & leadership Formulation**.**

TEXT BOOKS

1. Remesh.S., Vishnu R.G., *Life Skills for Engineers*, Ridhima Publications, 1st Edition, 2016.
2. *Life Skills for Engineers*, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016.

REFERENCES

1. Shiv Khera, *You Can Win*, Macmillan Books, NewYork,2003.
2. Barun.K. Mitra, *Personality Development &Soft Skills*, Oxford Publishers, Third impression, 2017.
3. Caruso, D. R. and Salovey P, *The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership*, John Wiley & Sons,2004.
4. Larry James, *The First Book of Life Skills*; Embassy Books, 1st Edition,2016.

COURSE PLAN

Module	Contents	No. of hours
I	**Overview of Life Skills**: Meaning and significance of life skills **Life skills identified by WHO**: Self- awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. **Life skills for professionals:** positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ, EQ, and SQ.	**6**
	Activities based on Creative thinking tools	
II	**Self-awareness**: Definition, need for self-awareness; Coping with Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback. **Stress Management**: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion-oriented, acceptance- oriented, resilience, Gratitude Training, Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques. **Morals, Values and Ethics**: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Cooperation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.	6
	Case studies on Morals and Ethics	
III	**21st century skills**: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.	6

	Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking Hats, Mind Mapping, Forced Connections.	
	Problem solving using Mind map/Six Thinking Hats	
IV	**Group and Team Dynamics**: Introduction to Groups: Composition, formation, Cycle, thinking, clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.	6
	Group Discussion: Differences between group discussion and debate; Ensuring success in group discussions.	6
V	**Leadership**: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.	6
	Presentation **Presentation Skills:** Oral presentation and public speaking skills; business presentations	
	Total hours	30

Life skills- Practical part

1. Activities based on Creative thinking tools
2. Case studies on Morals and Ethics
3. Problem solving using Mind map/Six Thinking Hats
4. Group Discussion: Differences between group discussion and debate; Ensuring success in group discussions.
5. Oral presentation and public speaking skills; business presentations.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	50	2 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Regular assessment	:	15 marks
Series test (one test only, should include first three modules)	:	25 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U18A	ENGINEERING PHYSICS LAB	BSC	0	0	2	1	2020

COURSE OVERVIEW:

The aim of this course is to enable the students to gain practical knowledge in Physics to correlate with the theoretical studies. It equips the students to utilize the acquired skills in an appropriate way to explore the prospects of modern technology. It brings more confidence in students and develop the ability to fabricate engineering and technical tools.

COURSE OUTCOMES

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

CO 1	Determine the frequency of tuning fork using a Meld's string apparatus by setting up wave pattern in a stretched string.	Understand
CO 2	Examine wave patterns using CRO to measure basic physical quantities viz. frequency and amplitude.	Remember
CO 3	Determine the wavelength of a monochromatic beam of light and thickness of thin wire using principle of interference.	Apply
CO 4	Demonstrate diffraction of light using plane transmission grating.	Understand
CO 5	Draw the I-V characteristics of non ohmic devices.	Remember

LIST OF EXPERIMENTS

1. Meld's string apparatus- Measurement of frequency in the transverse mode.
2. Wave length measurement of a monochromatic source of light using Newton's Rings method.
3. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.
4. Measurement of wavelength of a source of light using grating.
5. Determination of dispersive power and resolving power of a plane transmission grating.
6. Determination of the wavelength of any standard laser using diffraction grating
7. I-V characteristics of solar cell.
8. CRO-Measurement of frequency and amplitude of wave forms.

REFERENCES

1) S.L. Gupta and V. Kumar, *Practical physics with viva voce*, Pragati Prakashan Publishers, Revised Edition, 2009.
2) M.N. Avadhanulu, A.A. Dani and Pokely P.M., *Experiments in Engineering Physics*, S. Chand&Co, 2008.
3) S. K. Gupta, *Engineering Physics practicals*, Krishna Prakashan Pvt. Ltd., 2014
4) P. R. Sasikumar, *Practical Physics*, PHI Ltd., 2011.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	70	30	1 hour

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/ Assessment /Viva-voce	:	50 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18A	CIVIL AND MECHANICAL WORKSHOP	ESC	0	0	2	1	2020

COURSE OVERVIEW

The course is designed to train the students to identify and manage the tools, materials and methods required to execute basic Civil and Mechanical Engineering activities. Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing and executing a basic Engineering activity. It also enables the student to familiarize various tools, measuring devices, practices and different methods of manufacturing processes employed in industry for fabricating components.

COURSE OUTCOMES

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

CO 1	Name different devices and tools used for Civil Engineering measurements.	Remember
CO 2	Explain the use of various techniques and devices used in Civil Engineering measurements.	Understand
CO 3	Choose materials and methods required for basic Civil Engineering activities like field measurements, masonry work and plumbing.	Apply
CO 4	Demonstrate the steps involved in basic Civil Engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing and undertaking simple construction work.	Apply
CO 5	Identify the tools and equipment used in fitting, carpentry, sheet metal, foundry, welding and smithy and various machine tools.	Remember
CO 6	Prepare simple models in fitting, carpentry, sheet metal, foundry, welding and smithy trades.	Apply
CO 7	Apply general safety precautions in different mechanical workshop trades.	Understand

LIST OF EXPERIMENTS

PART I

CIVIL WORKSHOP

1) Set out a one room building of given plan using tape only method and using tape and cross staff.

2) a) Use screw gauge and Vernier calliper to measure the diameter of a steel rod and thickness of a flat bar.

   b) Calculate the area of a built-up space and a small piece of land- Use standard measuring tape and digital distance measuring devices.

3) a) Construct a wall using currently used building blocks such as bricks (1 ½ thick brick wall using English bond), hollow blocks, solid blocks, etc. Use spirit level to assess the tilt of walls.

b) Estimate the number of different types of building blocks required to construct a wall of given dimensions.

c) Transfer the level from one point to another point using a water level.

4) Find the level difference between any two points using dumpy level (differential levelling).

5) a) Introduce the students to plumbing tools, different types of pipes, types of connections, traps, valves, fixtures and sanitary fittings.

b) Study of installation of rain water harvesting system in an educational campus.

6) Introduce students to the principle and working of Total Station.

7) Demonstration of a simple construction work using concrete.

PART II
MECHANICAL WORKSHOP

1) General: Introduction to workshop practice, Safety precautions, Shop floor ethics, Basic First Aid knowledge, Study of mechanical tools
2) Carpentry: Understanding of carpentry tools and making minimum one model.
3) Foundry: Understanding of foundry tools and making minimum one model.
4) Sheet metal: Understanding of sheet metal working and making minimum one model.
5) Fitting: Understanding of fitting tools and making minimum one model.
6) Welding: Understanding of fitting tools and making minimum one model.
7) Smithy: Understanding of smithy tools and making minimum one model.
8) Machine Tools: Demonstration of various machines like shaping and slotting machine, milling machine, Grinding Machine, Lathe, Drilling Machine, CNC Machines, Power Tools.
Demonstration of 3D Printer.

REFERENCES

1) Khanna, P. N., *Indian Practical Civil Engineering Handbook*, Engineers Publishers, 2012.
2) Purnima, B. C., Ashok, K. J. and Arun, K.J., *Surveying*, Vol. I, Laxmi Publications (P) ltd., New Delhi, 17th Edition, 2016.
3) Arora, S. P. and Bindra, S. P., *Building Construction*, DhanpatRai Publications,43rd Edition,2019.
4) Rangwala, S. C., *Engineering Materials*, Charotar Publishing House, Anand, 43rdEdition, 2019.
5) Sawhney, G.S., *Mechanical Experiments and Workshop Practice*, Dreamtech Press, 2019.
6) Varun, B., *Engineering Workshop: Civil and Mechanical Engineering Practice*, Notion Press, 1stEdition, 2020.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	70	30	1 hour

Assessment Procedure: Total marks allotted for the course is 100 marks. CIE shall be conducted for 70 marks and ESE for 30 marks. CIE should be done for the work done by the student and also viva voce based on the work done on each practical session. ESE shall be evaluated by written examination of one hour duration conducted internally by the institute.

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/ Assessment /Viva-voce	:	50 marks
End semester examination (Internally by college)	:	30 marks

SEMESTER II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U10B	VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS	BSC	3	1	0	4	2020

COURSE OVERVIEW:

The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include the Calculus of vector valued functions, ordinary differential equations and basic transforms such as Laplace and Fourier Transforms which are invaluable for any engineer's mathematical tool box. The topics treated in this course have applications in all branches of engineering.

COURSE OUTCOMES

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

CO 1	Compute the derivatives and line integrals of vector functions and learn their applications.	Evaluate
CO 2	Evaluate surface and volume integrals and learn their inter-relations and applications.	Evaluate
CO 3	Solve linear ordinary differential equations.	Apply
CO 4	Apply Laplace transform to solve ODEs arising in engineering.	Apply
CO 5	Apply Fourier transforms of functions to solve problems arising in engineering.	Apply

SYLLABUS

Vector Calculus – Derivative of vector function, Gradient, Divergence, Curl, Line integral, conservative fields, Green's theorem, surface integral, Gauss divergence theorem, Stokes' theorem.

Ordinary Differential Equations- Homogeneous and Non-Homogeneous linear differential Equations, Euler-Cauchy equations. Method of undetermined coefficients and Method of variation of parameters.

Laplace transforms: Laplace Transform and its inverse, shifting theorems, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function. Dirac delta function, Convolution theorem and its applications.

Fourier Transforms: Fourier integral representation, Fourier sine and cosine integrals. Fourier transform and inverse Fourier transform. Fourier sine and cosine transforms, inverse sine and cosine transform, Convolution theorem.

TEXT BOOKS

1) H. Anton, I. Biven S. Davis, *Calculus*, Wiley, 10^{th}Edition, 2015.
2) Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley &Sons, 10^{th} Edition, 2016.

REFERENCES

1) George F Simmons*: Differential Equation with Applications and its historical Notes*, McGraw Hill Education India, 2^{nd} Edition, 2002.
2) Hemen Dutta, *Mathematical Methods for Science and Engineering*, CengageLearning,1^{st}Edition, 2020.
3) B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44^{th} Edition, 2018.

COURSE PLAN

Module	Contents	No. of hours
I	Calculus of vector functions: Vector valued function of single variable, derivative of vector function and geometrical interpretation, motion along a curve-velocity, speed and acceleration. Concept of scalar and vector fields, Gradient and its properties, directional derivative, divergence and curl, Line integrals of vector fields, work as line integral, Conservative vector fields, independence of path and potential function (results without proof).	12
II	Vector integral theorems: Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals and finding areas. Surface integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z) , Flux integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z), divergence theorem (without proof) and its applications to finding flux integrals, Stokes' theorem (without proof) and its applications to finding line integrals of vector fields and work done.	12
III	Ordinary differential equations: Homogenous linear differential equation of second order, superposition principle, general solution, homogenous linear ODEs with constant coefficients-general solution. Solution of Euler-Cauchy equations (second order only). Existence and uniqueness (without proof). Non homogenous linear ODEs-general solution, solution by the method of undetermined coefficients (for the right-hand side of the form xn, e^{kx}, $sinax$, $cosax$, $e^{kx}sinax$, e^{kx}cosax and their linear combinations), methods of variation of parameters. Solution of higher order equations-homogeneous and non-homogeneous with constant coefficient using method of undetermined coefficient.	12
IV	Laplace transforms: Laplace Transform and its inverse, Existence theorem (without proof), linearity, Laplace transform of basic functions, first shifting theorem, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function, Second shifting theorems. Dirac delta function and its Laplace transform, Solution of ordinary differential	12

	equation involving unit step function and Dirac delta functions. Convolution theorem (without proof) and its application to finding inverse Laplace transform of products of functions.	
V	Fourier Transforms: Fourier integral representation, Fourier sine and cosine integrals. Fourier sine and cosine transforms, inverse sine and cosine transform. Fourier transform and inverse Fourier transform, basic properties. The Fourier transform of derivatives. Convolution theorem (without proof).	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Class work/ Assessment /Viva-voce	:	25 marks
Continuous Assessment Tests	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U10A	ENGINEERING CHEMISTRY	BSC	3	1	0	4	2020

COURSE OVERVIEW:

The aim of the engineering chemistry program is to expose the students to basic concepts of chemistry and its industrial as well as engineering applications. It also let the students to familiarize with different topics such as new-generation engineering materials, storage-devices, different instrumental methods etc.

COURSE OUTCOMES

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

CO 1	Explain the basic concepts of electrochemistry and corrosion to explore its industrial functions in various engineering fields.	Understand
CO 2	Explain the various spectroscopic techniques like UV-Visible, IR, NMR and its applications.	Understand
CO 3	Apply the knowledge of analytical method for characterizing a chemical mixture or a compound. Understand the basic concept of SEM for surface characterisation of nanomaterials.	Apply
CO 4	Apply the knowledge of conducting polymers and advanced polymers in engineering.	Apply
CO 5	Explain various types of water treatment methods and to develop skills for treating industrial and domestic wastewater	Understand

SYLLABUS

Electrochemistry – Cell prototypes, Nernst equation and its uses, different types of cells and applications of electrochemical series. Fundamentals of corrosion and its prevention.

Basics of Spectroscopy – Principles and applications of UV-Vis, IR and NMR spectroscopy, instrumentation of UV-Vis spectroscope, colorimetry, MRI technique.

Instrumental methods in chemistry and Engineering materials – TGA, DTA, and chromatography techniques; Basics of polymer chemistry, BS, ABS and Kevlar and conducting polymers, Classifications of nanomaterials, synthesis, SEM, CNT, graphene.

Stereochemistry and polymer chemistry– Different types of isomers with examples; Notations; Conformational analysis, Types of polymers, ABS, Kevlar and applications, Polyaniline and Polypyrrole - preparation properties and applications, OLED.

Water Technology–Types of hard water and its elimination, DO, BOD and COD and its significance, disinfection of water, reverse osmosis, sewage water treatment.

TEXT BOOKS

1) D. Harvey, N. Rutledge, *Industrial Chemistry*, ETP,1stEdition, 2018. ISBN: 9781788820554
2) P. W. Atkins, J de Paula, *Atkins' Physical Chemistry*, Oxford University Press, 11thEdition 2014. ISBN: 9780199697403
3) M. Arif, A. Fernandez, K. P. Nair, *Engineering Chemistry*, Owl Books, 1st Edition, 2015.
4) S. Chawla, *A text book of Engineering Chemistry*, DhanpatRai& Co., 2nd Edition, 2013.

REFERENCES

1) C. N. Banwell, E. M. Mc Cash*, Fundamentals of Molecular Spectroscopy*, McGraw-Hill, 4thEdition, 2001. ISBN: 9780074620250
2) H. H. Willard, L. L. Merritt, *Instrumental Methods of Analysis*, CBS Publishers, 7thEdition, 2005. ISBN: 9788123909431
3) A. J. Peacock, A. Calhoun, C. Hanser*, Polymer Chemistry: Properties and Application*, Verlag GmbH & Company KG, 2012. ISBN: 9783446433434
4) C. Binns*, Introduction to Nanoscience and Nanotechnology*, Wiley, 2010. ISBN:9780471776475
5) Roy K. Varghese, *Engineering Chemistry*, 1stEdition, Crown plus Publishers, 2019.

COURSE PLAN

Module	**Contents**	**No. of hours**
I	**Electrochemistry and corrosion:** Introduction - Differences between electrolytic and electrochemical cells- Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes- SHE - Calomel electrode - Glass Electrode – Construction and Working. Single electrode potential – definition - Helmholtz electrical double layer - Determination of E^0 using calomel electrode. Determination of pH using glass electrode. Electrochemical series and its applications. Free energy and EMF-Nernst Equation – Derivation - single electrode and cell (Numerical) –Application-Variation of EMF with temperature. Potentiometric titration - Introduction -Redox titration only. Lithium ion cell - construction and working. Conductivity- Measurement of conductivity of a solution (Numerical). Corrosion-Electrochemical corrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.	12
II	**Spectroscopic Techniques and applications:** Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions – Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications. IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and - Determination of force constant of diatomic molecule (Numericals) –Applications. 1H NMR spectroscopy – Principle - Relation between field strength and frequency- chemical shift - spin-spin splitting (spectral	12

	problems) - coupling constant(definition) - applications of NMR-including MRI (brief).	
III	**Instrumental Methods and Nanomaterials:** Thermal analysis –TGA-Principle, instrumentation (block diagram) and applications – TGA of $CaC_2O_4.H_2O$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $CaC_2O_4.H_2O$. Chromatographic methods - Basic principles and applications of column and TLC-Retention factor. GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications. Nanomaterials - Definition - Classification - Chemical methods of preparation -Hydrolysis and Reduction - Applications of nanomaterials – Surface characterisation -SEM – Principle and instrumentation (block diagram).	12
IV	**Stereochemistry and Polymer Chemistry**: Isomerism-Structural, chain, position, functional, tautomerism and metamerism-Definition with examples - Representation of 3D Structures-Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations). R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples. Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane. Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications. Kevlar-preparation, properties and applications. Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.	12
V	**Water Chemistry and Sewage Water Treatment:** Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L - Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numerical). Water Softening Methods-Ion Exchange Process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Municipal water treatment (brief) - Disinfection methods - chlorination, ozone and UV irradiation. Dissolved oxygen (DO) -Estimation (only brief Procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals). Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process.	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10B	ENGINEERING GRAPHICS	ESC	2	0	2	3	2020

COURSE OVERVIEW:

Aim of the course is to enable the student to effectively perform technical communication through graphical representation as per global standards. The student will be able to apply the principles of projection and will be introduced to the fundamentals of Computer Aided Drawing (CAD).

COURSE OUTCOMES

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

CO 1	Construct the orthographic projection of points and lines located in different quadrants.	Apply
CO 2	Prepare multi view orthographic projection of solids by visualizing them in different positions.	Apply
CO 3	Construct sectional views and develop surfaces of a given solid.	Apply
CO 4	Prepare pictorial drawings using the principles of isometric and perspective projection to visualize objects in three dimensions.	Apply
CO 5	Convert pictorial views into orthographic views.	Apply
CO 6	Prepare multi view projection and solid models of objects using CAD tools.	Apply

SYLLABUS

Introduction - Relevance of technical drawing in engineering field, BIS code of practice for technical drawing.

Orthographic projection - Projection of points and lines in different quadrants, traces of line. Projection of solids in simple position, axis inclined to one reference plane and axis inclined to both reference planes.

Sections of Solids - Sections of solids cut by different section planes, true shape of the sections

Development of Surfaces - Development of surfaces of solids and solids cut by different section planes.

Isometric Projection - Isometric view and projection of solids and their combinations.

Perspective Projection - Perspective projection of solids with axis perpendicular to the ground plane and axis perpendicular to picture plane.

Conversion of Pictorial Views - Conversion of pictorial views into orthographic views.

Introduction to Computer Aided Drawing - Creating 2D drawing and 3D models of various components using suitable modelling software.

TEXT BOOKS

1) Bhatt N.D, *Engineering Drawing*, Charotar Publishing House Pvt. Ltd, 53rd Edition, 2019.
2) John K.C., *Engineering Graphics*, Prentice Hall India Publishers, 1st Edition, 2009.
3) C. M. Agrawal, Basant Agrawal, *Engineering Graphics*, Tata McGraw-Hill, 1stEdition, 2012.

REFERENCES

1) G. S. Phull, H. S. Sandhu, *Engineering Graphics*, John Wiley & Sons Inc Pvt. Ltd, 1stEdition, 2014.
2) P. I. Varghese, *Engineering Graphics*, V.I.P. Publishers,21st Edition, 2010.
3) Anil Kumar K.N., *Engineering Graphics*, Adhyuth Narayan Publishers, 4th Edition, 2009.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Relevance of technical drawing in engineering field. Types of lines, dimensioning, BIS code of practice for technical drawing. Orthographic projection of points and lines: Projection of points in different quadrants, projection of straight lines inclined to one plane and inclined to both planes. Trace of line, inclination of lines with reference planes, true length of line inclined to both the reference planes.	8
II	Orthographic projection of solids: Projection of simple solids such as triangular, rectangle, square, pentagonal and hexagonal prisms, pyramids, cone and cylinder. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.	9
III	Sections of Solids: Sections of prisms, pyramids, cone, cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Locating the section plane when the true shape of the section is given. Development of surfaces: Development of surfaces of the above solids and solids cut by different section planes. Finding the shortest distance between two points on the surface.	9
IV	Isometric projection: Isometric view and projection of prisms, pyramids, cone, cylinder, frustum of pyramid, frustum of cone, sphere, hemisphere and their combinations.	6
V	Perspective projection: Perspective projection of prisms and pyramids with axis perpendicular to the ground plane, axis perpendicular to picture plane. Conversion of pictorial view: Conversion of pictorial view into	5

	orthographic views.	
SECTION B *(To be conducted in CAD Lab)*		
	Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software. (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software. (Minimum 2 exercises mandatory)	8
	Total hours	45

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
CIA for section A carries	:	25 marks (15 marks for 1 test and Class work 10 marks)
CIA for section B carries	:	15 marks (10 marks for 1 test and Class work 5 marks)

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10D	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	ESC	4	0	0	4	2020

COURSE OVERVIEW

This course aims to equip the students with an understanding of the fundamental principles of electrical, electronics and communication engineering.

COURSE OUTCOMES

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

CO 1	Apply fundamental circuit laws and principles of electromagnetism to solve simple DC electric circuits and magnetic circuits respectively.	Apply
CO 2	Describe the fundamentals of AC generation to perform simple AC circuit analysis.	Understand
CO 3	Describe the principles of passive components, semiconductor devices and its characteristics.	Understand
CO 4	Explain the working of electronic circuits, instrumentation, radio and cellular communication systems.	Understand

SYLLABUS

Basic concepts of DC circuits: Ohm's Law and Kirchhoff's laws, Star-delta conversion, Analysis of DC circuits, Mesh analysis, Node analysis.

Magnetic Circuits: Basic Terminology, Simple Magnetic circuits, Electromagnetic Induction, Faraday's laws, Lenz's law, Self-inductance and mutual inductance.

Alternating Current fundamentals: Basic definitions, Average, RMS values, AC Circuits, Phasor representation, Analysis of simple AC circuits (R, L, C, RL, RC, RLC Series circuits) Three phase AC systems, Generation of three phase voltages, star and delta connections.

Introduction to Semiconductor devices: Evolution of electronics, Resistors, Capacitors, Inductors PN Junction diodes and Bipolar Junction Transistors.

Basic electronic circuits and instrumentation: DC power supply, Full wave bridge rectifier, Capacitor filter, Simple Zener voltage regulator, Amplifiers, Public Address system and Electronic Equipments.

Introduction to Communication Systems: Evolution of communication systems, Radio communication, Principle of antenna and Mobile communication.

TEXT BOOKS

1) William H. Hayt., Jr., Jack E. Kemmerly, Steven M. Durbin., *Engineering Circuit Analysis*, McGraw-Hill, 8th Edition, 2012.
2) Kothari D. P. and Nagrath I. J., *Basic Electrical Engineering*, Tata McGraw Hill, 2010.

3) Fitzgerald A.E., David Higginbotham E., Arvin Grabel, *Basic Electrical Engineering*, Tata McGraw Hill, 5^{th} Edition,2009.
4) Boylested, R. L. and Nashelsky, L., *Electronic Devices and Circuit Theory*, Pearson Education, 10^{th}Edition, 2009.
5) Wayne Tomasi and Neil Storey, *A Textbook on Basic Communication and Information Engineering*, Pearson, 5^{th}Edition, 2010.

REFERENCES

1) Paul Breeze, *Power Generation Technologies,* Newnes,3^{rd} Edition, 2019.
2) Allan Hambley R., *Electrical Engineering: Principles & Applications*, Pearson Education,7^{th}Edition, 2018.
3) Mittle V. N. and Arvind Mittal, *Basic Electrical Engineering*, McGraw Hill,2^{nd}Edition, 2006.
4) N.N. Bhargava , D.C. Kulshreshtha , S.C. Gupta, *Basic Electronics and Linear Circuits*, Tata McGraw - Hill Education, New Delhi, 2^{nd} Edition, 2014.

COURSE PLAN

Module	Contents	No. of hours
	DC circuits: Review of Elementary concepts of DC circuits, Current and Voltage Division Rules, Star-delta conversion (resistive networks only-derivation not required), Numerical problems.	
I	**Analysis of DC circuits:** Mesh current method, Node voltage method. Solution of network equations by matrix method, Numerical problems.	9
	Magnetic Circuits: Review of Magnetic Circuits, Series magnetic circuits with composite materials, Numerical problems.	
	Electromagnetic Induction: Faraday's laws, Lenz's law, statically induced and dynamically induced emfs, Self-inductance and mutual inductance, coefficient of coupling (derivation not required), Numerical Problems.	
II	**Alternating Current fundamentals:** Generation of alternating voltages, Basic definitions, Average and RMS values of sinusoidal waveforms, Numerical Problems.	9
	Power Generating Stations: Solar, Wind, Hydro-electric and Nuclear power stations, Basic concepts with block diagrams only.	

III	**Analysis of AC Circuits:** Transient Analysis of RL circuit, Steady state Analysis of RL circuit, Phasor representation of sinusoidal quantities, Complex forms. **Analysis of simple AC circuits:** Purely resistive, inductive and capacitive circuits; Analysis of RL, RC and RLC series circuits, active, reactive and apparent power. Illustrations using simple example.	12
	Three phase AC systems: Generation of three phase voltages, advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents, Power in three phase circuit, Numerical problems.	
IV	**Introduction to Semiconductor devices**	
	Evolution of electronics – Vacuum tubes to nano electronics (In evolutional perspective only)	1
	Resistors, Capacitors and Inductors: types, specifications, standard values, colour coding (No constructional features)	2
	PN Junction diode: Principle of operation, V-I characteristics, principle of avalanche breakdown and Zener breakdown	2
	Bipolar Junction Transistors: PNP and NPN structures, principle of operation, relation between current gains in CE, CB and CC Configurations, input and output characteristics of common emitter configuration.	5
V	**Basic electronic circuits and instrumentation**	
	Rectifiers and Power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator	3
	Amplifiers: Concept of voltage divider biasing, circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, block diagram of Public Address system.	5
	Electronic Instrumentation: Block diagram of an electronic instrumentation system, functions of various equipments (multimeter, DSO and function generator)	2
VI	**Introduction to Communication Systems**	
	Evolution of communication systems: Telegraphy to 5G	1
	Radio communication: Principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver. **Principle of antenna:** Radiation from accelerated charge	5

	Mobile communication: Basic principles of cellular communications, principle and block diagram of GSM.	**4**
	Total hours	**60**

Suggested Simulation Assignments for Basic Electronics Engineering

(1) Plot V-I characteristics of Si and Ge diodes on a simulator.
(2) Plot Input and Output characteristics of BJT on a simulator.
(3) Implementation of half wave and full wave rectifiers.
(4) Simulation of RC coupled amplifier with the design supplied.
(5) Generation of AM signal.

Note: The simulations can be done on open tools such as Proteus, QUCS, KiCad, GNURadio or similar software to augment the understanding.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment/Quiz/Course Project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10B	PROFESSIONAL COMMUNICATION	HSC	2	0	2	--	2020

COURSE OVERVIEW:

The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators. The course aims to enhance the employability and career Skills of students and orient the students towards grooming as a professional.

COURSE OUTCOMES

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

CO 1	Develop effective language skills relevant to Engineering as a profession and demonstrate these through writing and making presentations.	Create
CO 2	Analyze, interpret and effectively summarize a variety of textual and audio content for specific needs	Analyse
CO 3	Apply appropriate thinking and problem solving techniques to solve new case studies.	Apply
CO 4	Present and analyses a given technical/non-technical topic in a group setting and arrive at generalizations/consensus.	Analyse
CO 5	Create professional and technical documents that are clear and adhering to all the necessary conventions.	Create
CO 6	Manage and apply interviewing skills.	Apply

SYLLABUS

Communication Skills: Introducing yourself and others professionally, elevator pitch, recommendation letter, e-mails, netiquettes, telephone etiquettes, demi-official letters.

Business Communication and Technical writing: Product description, narrating an incident, report writing, agenda and minutes, memo, asking for information and giving information, explaining processes and products, giving instructions, planning a course of action.

Creative Thinking, Critical Thinking Skills and problem solving: Expressing opinion, GD, Arguing, reading critical texts (general and academic) and summarizing, listening and responding, Negotiation strategies and decision making skills.

Presentation Skills: Oral Presentation Skills (Proposal presentation), Power point presentation (Projects).

Interviews: CVs and Resumes, Job application, Types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (Skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews.

TEXT BOOKS

1. Meenakshi Raman and Sangeetha Sharma (2018). *Professional Communication*, Oxford University Press, 3rdEdition, 2018.
2. Meenakshi Raman and Sangeetha Sharma*, Technical Communication: Principles and Practice*, Oxford University Press, 2nd Edition, 2011.
3. Ashraf Rizvi M., *Effective Technical Communication*. New Delhi: Tata McGraw Hill Publications, 2007.

REFERENCES

1. *English for Engineers and Technologists* (Combined edition, Vol. 1 and 2, Orient Blackswan, 2010.
2. Stephen E. Lucas, *The Art of Public Speaking*, 10th Edition; McGraw Hill Education, 2012.
3. William Strunk Jr. & E.B. White, *The Elements of Style*, 4thEdition, Pearson, 1999.
4. David F. Beer and David*, Guide to writing as an Engineer*, John Willey. New York, 2004.
5. Goodheart-Willcox, *Professional Communication*, 1stEdition, 2017.
6. *Training in Interpersonal Skills: Tips for Managing People at Work,* Pearson Education, India, 6th Edition,2015.
7. *The Ace of Soft Skills: Attitude, Communication and Etiquette for Success*, Pearson Education; 1st Edition, 2013.
8. Anand Ganguly, *Success in Interview*, RPH, 5thEdition, 2016.
9. Raman Sharma, *Technical Communications*, Oxford Publication, London, 2004.

COURSE PLAN

Module	**Contents**	**No. of hours**
I	Use of language in communication: Significance of technical communication Vocabulary Development: technical vocabulary, vocabulary used in formal letters/emails and reports, sequence words, misspelled words, compound words, finding suitable synonyms, paraphrasing, verbal analogies. Language Development: subject-verb agreement, personal passive voice, numerical adjectives, embedded sentences, clauses, conditionals, reported speech, active/passive voice. Technology-based communication: Effective email messages, slide presentations, editing skills using	**6**

	software. Modern day research and study skills: search engines, repositories, forums such as GitHub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism	
II	Reading, Comprehension, and Summarizing: Reading styles, speed, valuation, critical reading, reading and comprehending shorter and longer technical articles from journals, newspapers, identifying the various transitions in a text, SQ3R method, PQRST method, speed reading. Comprehension: techniques, understanding textbooks, marking and underlining, Note-taking: recognizing non-verbal cues.	**6**
III	Oral Presentation: Voice modulation, tone, describing a process, Presentation Skills: Oral presentation and public speaking skills, business presentations, Preparation: organizing the material, self-introduction, introducing the topic, answering questions, individual presentation practice, presenting visuals effectively. Debate and Group Discussions: introduction to Group Discussion (GD), differences between GD and debate; participating GD, understanding GD, brainstorming the topic, questioning and clarifying, GD strategies, activities to improve GD skills.	**6**
IV	Listening and Interview Skills Listening: Active and Passive listening, listening: for general content, to fill up information, intensive listening, for specific information, to answer, and to understand. Developing effective listening skills, barriers to effective listening, listening to longer technical talks, listening to classroom lectures, talks on engineering /technology, listening to documentaries and making notes, TED talks. Interview Skills: types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews.	**6**
V	Formal writing: Technical Writing: differences between technical and literary style. Letter Writing (formal, informal and semi-formal), Job applications, Minute preparation, CV preparation (differences between Bio-Data, CV and Resume), and Reports. Elements of style, Common Errors in Writing: describing a process, use of sequence words, Statements of Purpose, Instructions, Checklists.	**6**

	Analytical and issue-based Essays and Report Writing: basics of report writing; Referencing Style (IEEE Format), structure of a report; types of reports, references, bibliography	
	Total Hours	**30**

Lab Activities

Written: Letter writing, CV writing, Attending a meeting and Minute Preparation, Vocabulary Building

Spoken: Phonetics, MMFS (Multimedia Feedback System), Mirroring, Elevator Pitch, telephone etiquette, qualities of a good presentation with emphasis on body language and use of visual aids.

Listening: Exercises based on audio materials like radio and podcasts. Listening to Song practice and exercises.

Reading: Speed Reading, reading with the help of Audio Visual Aids, Reading Comprehension Skills

Mock interview and Debate/Group Discussion: concepts, types, Do's and don'ts- intensive practice.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	50	50	2 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Class work/ Assessment /Viva-voce	:	25 marks
Continuous Assessment Tests	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10E	PROGRAMMING IN C	ESC	2	1	2	4	2020

COURSE OVERVIEW:

This course aims to introduce the concepts of structured programming. It covers basic concepts of C programming language including arrays, functions, pointers and files. This course involves a lab component which equips the learner to solve computational problems through programming.

COURSE OUTCOMES

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

CO 1	Explain the fundamentals of computer architecture and types of software.	Understand
CO 2	Develop a solution using algorithm /flowchart to a computational problem.	Apply
CO 3	Construct programs with control statements and arrays.	Apply
CO4	Make use of user defined data types or functions to solve computational problems.	Apply
CO5	Develop programs using files and pointers.	Apply

SYLLABUS

Computer architecture & Programming Languages – Basics of Computer architecture, Types of Programming Languages, System Software, Application Software, Introduction to structured programming, Algorithms, Flowcharts and Pseudo-codes

C Programming Language – Data Types, variables, keywords, Constants, Operators and Expressions, Control Flow Statements- Conditional statements, Iterative statements, programs

Arrays and Strings– Multidimensional arrays and matrices, String processing, searching and sorting in 1D array.

Functions – Scope of variable, Pass by reference and value methods, Recursive functions. Structures and union, Storage Classes

Pointers and Files- File Operations, Sequential access and random access, programs covering pointers and files, Introduction to data structures – Types of data structure, singly linked list.

TEXT BOOKS

1) Byron Gottfried, *Programming with C* (Schaum's Outlines Series), Mcgraw Hill Education, 3rd Edition, 2017.
2) H. M. Deitel, P. J. Deitel, *C: How to program*, 7th Edition, Pearson Education, 2010.
3) Anita Goel, Computer Fundamentals, Pearson, 1st Edition, 2010.

4) Ellis Horowits, Sartaj Sahini, Susan Anderson Freed, *Fundamentals of Data Structures in C*, 2nd Edition, 2008.

REFERENCES

1) Brian W. Kernighan and Dennis M. Ritchie, *C Programming Language*, Pearson, 2nd Edition, 2015.
2) Rajaraman V, PHI, *Computer Basics and Programming in C*, 1st Edition, 2007.
3) Anita Goel and Ajay Mittal, *Computer fundamentals and Programming in C*, 1st Edition, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Basics of Computer architecture. -Von-Neumann Architecture- Processor, Memory, Input and Output devices. Types of Programming Languages, System Software, Application Software: Compilers, Interpreters, high level and low level languages Introduction to structured programming, Algorithm, flowcharts and Pseudo-code -Examples	**8**
II	Basic structure of C program: Character set, Tokens, Identifiers in C, Variables and Data Types, Constants, Console IO Operations, printf and scanf, Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence. Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue statements.	**9**
III	Arrays. Strings-string handling functions. Multidimensional arrays and matrices. Linear search and Bubble Sort in array. String processing: In built string handling functions Simple programs covering arrays and strings	**9**
IV	Functions: The prototype declaration, Function definition. Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls. Storage Classes. Structure and union in C, Array of structures	**8**
V	Pointers: Pointer variables. Declaring and dereferencing pointer variables. Accessing arrays through pointers. File Operations: open, close, read, write, append Sequential access and random access to	**11**

	files: In built file handling functions (rewind (), fseek (), ftell (), feof (), fread (), fwrite ()), simple programs covering pointers and files. Introduction to Data Structures: Linear and Non-linear data structures, Singly Linked list and its operations.	
	Total hours	**45**

C PROGRAMMING LAB (Practical Part of ES0U10E)

1. Familiarization of console I/O and operators in C
   i) Display "Hello World"
   ii) Read two numbers, add them and display their sum
   iii) Read the radius of a circle, calculate its area and display it
   iv) Area of triangle after reading its sides
2. Read 3 integer values and find largest of three numbers.
3. Check whether given year is leap year.
4. Display the grade of a student after reading his mark for a subject. (Use switch)
5. Read a Natural Number and check whether the number is prime or not
6. Read a Natural Number and check whether the number is Armstrong or not
7. Display second largest number after reading n numbers from user. (Without array).
8. Read n integers, store them in an array and find their sum and average
9. Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search
10. Read n integers, store them in an array and sort the elements in the array using Bubble Sort algorithm
11. Write a menu driven program for performing matrix addition, multiplication and finding the transpose. Use functions to (i) read a matrix, (ii) find the sum of two matrices, (iii) find the product of two matrices, (i) find the transpose of a matrix and (v) display a matrix.
12. Display sum of diagonal elements of a matrix
13. Read a string (word), store it in an array and check whether it is a palindrome word or not.
14. Read a string (ending with a $ symbol), store it in an array and count the number of vowels, consonants and spaces in it.
15. Display first n prime numbers using Function.
16. Program to find the sum of digits of a number using recursion
17. Using structure, read and print data of n employees (Name, Employee Id and Salary)
18. Read the marks of three subjects for n students of a class and display their names in the order of rank. (Use array of structure)
19. Input and Print the sum of elements of an array using pointers
20. Create a file and perform the following
   i) Write data to the file
   ii) Read the data in a given file & display the file content on console
   iii) append new data and display on console
21. Open a text input file and count number of characters, words and lines in it; and store the results in an output file.
22. Implementation of Singly Linked List.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Test 1 (for theory, for 2 hrs)	:	20 marks
Continuous Assessment Test 2 (for lab, internal examination, for 2 hrs)	:	20 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U18A	ENGINEERING CHEMISTRY LAB	BSC	0	0	2	1	2020

COURSE OVERVIEW:

This course is designed to familiarize with the basic experiments in industrial chemistry and to accustom the students with the handling and analysing chemicals and standard laboratory equipments.

COURSE OUTCOMES

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

CO 1	Apply different techniques of quantitative chemical analysis to generate basic experimental skills.	Apply
CO 2	Explain the use of spectroscopic techniques for analysing and interpreting the IR spectra and NMR spectra of some organic compounds.	Understand
CO 3	Use instrumental techniques for chemical analysis.	Apply
CO 4	Organize scientific experiments as a team and analyse the results of such experiments.	Evaluate
CO 5	Create an experiment by themselves and applying them to real world problems and data.	Create

LIST OF EXPERIMENTS

1. Estimation of total hardness of water by EDTA method.
2. Analysis of IR and 1H NMR spectra of organic compounds.
3. Determination of wavelength of absorption maximum and colorimetric estimation of Fe3+ in solution.
4. Determination of molar absorptivity of a compound.
5. Estimation of chloride in water by argentometric method.
6. Calibration of pH meter and determination of pH of a solution.
7. Potentiometric titration: Acid – base titration.
8. Estimation of dissolved oxygen in water by Winkler's method.

REFERENCES

1) Mohapatra R. K., *Engineering Chemistry with Laboratory Experiments*, PHI Learning, New Delhi, 1stEdition, 2015.
2) George S . C., Jose R., *Lab Manual of Engineering Chemistry*, S. Chand & Company Pvt Ltd, New Delhi, 1st Edition, 2019.
3) Slowinskie Wolsey W. C., *Chemical Principles in the Laboratory*, Cengage Learning, New Delhi, 11thEdition, 2008.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	70	30	1 hour

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/ Assessment /Viva-voce	:	50 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18B	ELECTRICAL AND ELECTRONICS WORKSHOP	ESC	0	0	2	1	2020

COURSE OVERVIEW:

- To expose the students to the commonly used accessories and components in electrical installations and to provide hands on experience of wiring of electrical circuits.
- To enable the students to familiarize, identify, construct, and debug the electronic components, devices and circuits. It also enables the students engineering skills by soldering practices of electronic circuits.

COURSE OUTCOMES

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

CO 1	Identify electrical accessories, protective elements and their standard symbols and the tools used for electrical wiring.	Remember
CO 2	Develop the connection diagram, identify the suitable accessories and materials necessary for wiring simple lighting circuits for domestic buildings.	Apply
CO 3	Identify different types of batteries and different types of earthing.	Remember
CO 4	Explain the working and purpose of fuse, MCB, ELCB etc. and solar powered circuit.	Understand
CO 5	Identify and test various electronic components.	Understand
CO 6	Draw circuit schematics with EDA tools.	Apply
CO 7	Assemble and test electronic circuits on boards.	Apply

LIST OF EXPERIMENTS

PART I
ELECTRICAL WORKSHOP

1 Familiarization/Identification of electrical components with specification (Functionality, type, size, colour coding, symbol, cost etc. of Wires, Cables, Connectors, Fuses, MCB, ELCB, Switches and other electrical installation equipments with ratings).
2 Wiring of one lamp controlled by one SPST switch and a plug socket (PVC conduit wiring).
3 Wiring of light/fan circuit controlled by two SPDT switches (Staircase wiring).
4 Wiring of a light circuit and a power circuit for domestic applications.
5 Wiring of simple solar chargeable circuit and determination of its characteristics.
6 Demonstration of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.

7 Understand the safety precautions to be observed in the workshop and learn about safety procedures of first aid in case of electrical hazards.
8 Video demonstration of Pipe and Plate Earthing Schemes.

PART II
ELECTRONICS WORKSHOP

1 Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. (Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.))
2 Drawing of electronic circuit diagrams using standard symbols and introduction to EDA tools, Interpret data sheets of discrete components and IC's, Estimation and costing.
3 Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, DSO etc.] [Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de- soldering station etc.]
4 Testing of electronic components [Resistor, Capacitor, Diode, Transistor and JFET using multimeter]
5 Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general-purpose PCB, Crimping.]
6 Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design (using Proteus) and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]
7 Assembling of electronic circuit/system on general purpose PCB, test and show the functioning
   a. Fixed voltage power supply with transformer, rectifier diode, capacitor filter, Zener/IC regulator
   b. Square wave generation using IC 555 timer in IC base.

REFERENCES

1) Singh R. P., *Electrical Workshop: Safety, Commissioning, Maintenance & Testing of Electrical Equipment*, Dream tech Press, 3rd Edition, 2019.
2) John H. Watt, *Terrell Croft American Electricians' Handbook: A Reference Book for the Practical Electrical Manual*, McGraw-Hill, 9th Edition, 2002.
3) Navas K A, *Electronics Lab Manual*, Volume 1, PHI Learning Private Limited, 5th Edition, 2015.

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
100	100	30	1 hour

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	20 marks
Class work/ Assessment /Viva-voce	:	50 marks

SEMESTER III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20B	Discrete Mathematical Structures	BSC	3	1	0	4	2020

PRE REQUISITE: A sound background in higher secondary school Mathematics

COURSE OVERVIEW:

The purpose of this course is to create awareness in students about the basic terminologies used in advanced courses in Computer Science and develop rigorous logical thinking for solving different kinds of problems in Computer Science. This course helps the learner to apply the theory and applications of elementary Counting Principles, Propositional Logic, Predicate Logic, Lattices, Generating Functions, Recurrence Relations and Algebraic Structures eventually in practical applications.

COURSE OUTCOMES

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

Course Outcomes	Description	Learning Level
CO 1	Using truth tables, deductive reasoning and inference theory on Propositional Logic check the validity of predicates in Propositional and Quantified Propositional Logic	Apply
CO 2	Solve counting problems by applying the elementary counting techniques - Rule of Sum, Rule of Product, Permutation, Combination, Binomial Theorem, Pigeonhole Principle and Principle of Inclusion and Exclusion	Apply
CO 3	Classify binary relations into various types	Understand
CO 4	Illustrate an application for Partially Ordered Sets and Complete Lattices	Apply
CO 5	Solve First Order and Second Order Linear Recurrence Relations with Constant Coefficients using generating functions.	Apply
CO 6	Describe the fundamentals of abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups	Understand

SYLLABUS

Mathematical logic - Tautology, Contradiction. Logical Equivalence - The Laws of Logic, The Principle of duality. Logical Implication - Rules of Inference. The use of Quantifiers–Logical equivalences and implications for quantified statement, Implications, Negation.

The Rule of Sum-Permutations. Combinations- The Binomial Theorem. The Pigeon hole Principle. The Principle of Inclusion and Exclusion - Generalization of the Principle. Derangements.

Cartesian Product - Binary Relation and Functions. - Reachability Relations, Equivalence Relations and partitions. Partial Order relations, Partially ordered Set - Lattice, Properties of Lattice.

Generating Function - First order linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Second order linear recurrence relations with constant coefficients, homogeneous, non-homogeneous Solution.
Algebraic Systems-Semi group and monoid-cyclic monoid, Homomorphism and Isomorphism. Group- subgroup, symmetric group, The direct product of two groups, Group Homomorphism-Cyclic Group-Right cosets and Lagrange's Theorem

TEXT BOOKS

1. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana, 5th Edition, Pearson

REFERENCES

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, Seventh Edition, MGH, 2011
2. Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2003.
3. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi, 2003

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 5/e, Tata Mc Graw Hill Pub. Co. Ltd, New Delhi 2003
2. Richard Johnsonbaugh, "Discrete Mathematics", 5/e, Pearson Education Asia, NewDelhi, 2002.
3. Joe L Mott, Abraham Kandel, Theodore P Baker, "Discrete Mathematics for Computer Scientists and Mathematicians", 2/e, Prentice-Hall India, 2009.

COURSE PLAN

Module	Contents	No. of hours
I	Mathematical logic, Basic Connectives and Truth Table Statements, Logical Connectives, Tautology, Contradiction Logical Equivalence, The Laws of Logic, The Principle of duality, Substitution Rules The implication, The Contrapositive, the Converse, the Inverse Logical Implication, Rules of Inference, Logical Implication	12

	The use of Quantifiers, Open Statement, Quantifier, Negation Logically Equivalent, Contrapositive, The Converse, The Inverse Logical Implications	
II	The Pigeon-hole Principle-The Rule of Sum-Extension of Sum Rule The Rule of Product-Extension of Product Rule, Permutations Combinations, Combination with repetition-The Binomial Theorem (Without Proof)-The Principle of Inclusion and Exclusion Theorem (Without Proof) Generalization of the Principle Derangements	12
III	Cartesian Product, Binary Relation, Function, Domain, Range, One to One Function Image – Restriction properties, Reachability Relations, Reflexive Relations, Symmetric Relations, Transitive relations, Antisymmetric Relations-Partial Order relations Equivalence Relation, Irreflexive Relations. Partially ordered Set, Hasse Diagram Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound Equivalence Relations and Partitions, Equivalence Class Lattice- Dual Lattice, sub lattice, Properties of glb and lub Properties of Lattice, Special Lattice, Complete Lattice, Bounded Lattice, Completed Lattice, Distributive Lattice	12
IV	Generating Function, Definition and Examples Exponential Generating Function. First Order Linear Recurrence Relations with Constant Coefficients First Order Linear Recurrence Relations with Constant Coefficients Homogeneous Solution Non homogeneous Solution Second order linear recurrence relations with constant Coefficients Homogeneous Solution Non homogeneous Solution	12
V	Algebraic System-Properties, Homomorphism and Isomorphism Semi group, Monoid, Cyclic monoid Sub semigroup and sub monoid Homomorphism and Isomorphism of Semigroup, Monoids and Groups Elementary Properties, Subgroup, Symmetric group on three Symbols .The direct Product of two Groups-Group Homomorphism, Isomorphism, Cyclic group ,Right coset, Left coset ,Lagrange's Theorem	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20A	Data Structures	PCC	3	1	0	4	2020

PRE-REQUISITE: ES0U10E Programming in C

COURSE OVERVIEW:

This course aims to introduce the various data structures, their organization and operations. It covers abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps and graphs. It helps the learner to apply appropriate data structures and associated algorithms for solving real world problems efficiently.

COURSE OUTCOMES

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

CO 1	Design an algorithm for a computational task and calculate the time/space complexities.	Apply
CO 2	Identify suitable data structure (array or linked list) to represent a data item required to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem.	Apply
CO 3	Design an algorithm to find the solution of a computational problem by selecting an appropriate data structure (binary tree/graph) to represent a data item to be processed.	Apply
CO 4	Apply appropriate Hash Function to store a given dataset and enable efficient access of data in the given set.	Apply
CO 5	Make use of appropriate sorting algorithms based on specific circumstances.	Apply

SYLLABUS

Introduction: Basic Concepts of Data Structures, Algorithms, Performance Analysis, Asymptotic Notation, Complexity Calculation of Simple Algorithms.

Arrays and Searching: Sparse matrix, Stacks and Queues, Linear Search and Binary Search.

Linked List and Memory Management: Operations on Linked List, Types of Linked Lists, Stacks and Queues, Memory allocation and deallocation -First-fit, Best-fit and Worst-fit.

Trees and Graphs: Binary Trees, Binary Search Trees, Graph Representations, Depth First Search and Breadth First Search, Applications of Graphs.

Sorting and Hashing: Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions.

TEXT BOOKS

1) Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C.

REFERENCES

1) Samanta D., Classic Data Structures, Prentice Hall India.
2) Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
3) Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
4) Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Basic Concepts of Data Structures, System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms	8
II	Arrays and Searching: Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions, Linear Search and Binary Search	14
III	Linked List and Memory Management: Self-Referential Structures, Dynamic Memory Allocation, Operations on Linked List-Singly Linked List, Doubly Linked List, Circular Linked List. Stacks and Queues using Linked List, Polynomial representation using Linked List, Memory allocation and deallocation-First-fit, Best-fit and Worst-fit allocation schemes	14

IV	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations, Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs	14
V	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing-Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis	10
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20B	Logic System Design	PCC	3	1	0	4	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: The goal of this course is to impart an understanding of the basic concepts of Boolean algebra and digital systems. This course covers the design and implementation of different types of practically used combinational and sequential circuits. This course helps the learners to develop application level digital logic circuits to solve real life problems.

COURSE OUTCOMES

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

CO 1	Illustrate decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers .	Understand
CO 2	Simplify a given Boolean Function and design a combinational circuit to implement the simplified function using Digital Logic Gates.	Apply
CO 3	Design combinational circuits - Adders, Code Converters, Decoders, Magnitude Comparators, Parity Generator/Checker and design the Programmable Logic Devices -ROM and PLA.	Apply
CO 4	Design sequential circuits - Registers, Counters and Shift Registers.	Apply
CO 5	Illustrate algorithms to perform addition and subtraction on binary, BCD and floating point numbers.	Understand

SYLLABUS

Number systems, Operations & Codes: Various Number systems - its arithmetic operation - Number Base Conversions- Representation of negative numbers-BCD Arithmetic-Binary codes- character coding schemes.

Boolean Algebra: Postulates- Basic theorems and properties of Boolean Algebra-Boolean Functions-Simplification of Boolean Functions-Don't care Conditions-Digital Logic Gates

Combinational Logic circuits: Design procedure & Implementation of Binary Adders and Subtractors- BCD Adder-Code Converter-Comparator-Decoder/Encoder-Demux /Mux-Parity Generator/Checker.

Sequential logic circuits: Flip-flops- Triggering of flip-flops- Master Slave flip- flops - Excitation table and Characteristic Equation-Counter Design: Asynchronous & Synchronous Counters.

Shift registers: Shift register, Ring Counter- Johnson Counter
Arithmetic algorithms: Algorithms for arithmetic operations on Negative Numbers-BCD-Floating Point Numbers-Programmable Logic Devices: ROM-Implementation of PLA.

TEXT BOOKS

1) M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
2) Thomas L Floyd, Digital Fundamentals, 10/e, Pearson Education, 2009.
3) M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

REFERENCES

1) M. Morris Mano, Michael D Ciletti , Digital Design With An Introduction to the Verilog HDL, 5/e, Pearson Education, 2013.
2)Donald D Givone, Digital Principles and Design, Tata McGraw Hill, 2003.

COURSE PLAN

Module	Contents	No. of hours
I	**Number systems, Operations & Codes** Decimal, Binary, Octal and Hexadecimal Number Systems- Number Base Conversions. Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary codes- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC.	12
II	**Boolean Algebra** Postulates of Boolean Algebra. Basic theorems and Properties of Boolean Algebra. Boolean Functions - Canonical and Standard forms. Simplification of Boolean Functions- Using Karnaugh- Map Method (upto five variables), Don't care conditions, Product of sums simplification, Tabulation Method. Digital Logic Gates- Implementation of Boolean functions using basic and universal gates.	12
III	**Combinational Logic Circuits** Design Procedure & Implementation of combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, DE multiplexer, Encoder, Multiplexer, Parity generator/ Checker	12
IV	**Sequential logic circuits** Flip-flops- SR, JK, T and D. Triggering of flip-flops- Master slave flip-flops, Edge- triggered flip- flops. Excitation table and characteristic equation. Registers- register with parallel load. Counter design: Asynchronous counters- Binary and BCD counters, timing sequences and state diagrams. Synchronous counters- Binary Up- down	12

	counter, BCD counter.	
V	**Shift registers** Shift registers – Serial In Serial Out, Serial In Parallel Out, Bidirectional Shift Register with Parallel load. Ring counter. Johnson counter- timing sequences and state diagrams. **Arithmetic algorithms** Algorithms for addition and subtraction of binary numbers in signed magnitude and 2's complement representations. Algorithm for addition and subtraction of BCD numbers. Representation of floating point numbers, Algorithm for addition and subtraction of floating point numbers. **Programmable Logic devices** ROM. Programmable Logic Array(PLA)- Implementation of simple circuits using PLA.	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20C	Object Oriented Programming using java	PCC	3	1	0	4	2020

PRE-REQUISITE: ES0U10E Programming in C

COURSE OVERVIEW:

Aim of the course is to introduce Object oriented concepts in programming. The course covers Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. The course will enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java.

COURSE OUTCOMES

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

CO 1	Apply the object oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism to write java programs.	Apply
CO 2	Utilise datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs.	Apply
CO 3	Illustrate how robust programs can be written in Java using exception handling mechanism.	Understand
CO 4	Utilise multithreading and database connectivity to develop java applications.	Apply
CO 5	Apply event handling features and swing to develop Graphical User Interface based java application programs .	Apply

SYLLABUS

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Object Modeling Using Unified Modeling Language (UML) – Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram. Introduction to Java - Java programming Environment and Runtime Environment, Java Virtual Machine (JVM), Java compiler, Bytecode.

Core Java Fundamentals: Data types, Operators, Control Statements, Object Oriented Programming in Java - Class Fundamentals, Constructors, Method Overloading, Access Control, Command Line Arguments, Inheritance - Method Overriding, Abstract Classes and Methods.

Packages and Interfaces, Interfaces, Exception Handling, Input/ Output - Reading Console Input, Writing Console Output, Object Streams and Serialization, Working with Files.

Java Library, String Handling, Comparison of String Buffer and String, Collections framework, Collections Class, Event handling - Delegation Event Model, Multithreaded Programming.

Swings fundamentals - Model View Controller (MVC), Event Handling in Swings, Exploring Swings, Java Database Connectivity (JDBC).

TEXT BOOKS

1) Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2) Bahrami A., Object Oriented Systems Development using the Unified Modeling Language, McGraw Hill, 1999.
3) Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

REFERENCES

1) Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2) Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3) Balaguruswamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

COURSE PLAN

Module	Contents	No. of hours
I	Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Case Study of Automated Fire Alarm System. Object Modeling Using Unified Modeling Language (UML) – Basic Object Oriented concepts, UML diagrams, Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram. Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues.	10

II	Core Java Fundamentals: Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Variable Length Arguments. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using final with Inheritance.	14
III	More features of Java: Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. Input/ Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.	12
IV	Advanced features of Java: Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using value Of(), Comparison of String Buffer and String. Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – Array List class. Accessing a Collection via an Iterator. Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	12

V	Graphical User Interface and Database support of Java: Swings fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, JTextField. Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	12
	Total hours (Approx.)	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U20A	Professional Ethics	HSC	2	0	0	2	2020

COURSE OVERVIEW:

To enable students to create awareness on ethics and human values.

COURSE OUTCOMES

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

CO 1	Infer the core values that shape the ethical behaviour of a professional.	Understand
CO 2	Apply philosophical concepts discussed in the course to personal and contemporary issues.	Apply
CO 3	Explain the role and responsibility of engineer in technological development without compromising personal ethics and legal ethics.	Understand
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.	Apply
CO 5	Demonstrate the concept of Corporate Social Responsibility, and explore its relevance to ethical business activity.	Understand
CO 6	Apply the knowledge of human values and social values to contemporary ethical values and global issues.	Apply

SYLLABUS

Morals, values and Ethics – Integrity- Academic Integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- Courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas – Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional Roles-Theories about right action – Self-Interest-Customs and Religion- Uses of Ethical Theories.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics-Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining-Confidentiality- Role of confidentiality in moral Integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and Advisors-Moral leadership.

TEXT BOOKS

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, NewDelhi, 2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi, 2006.

REFERENCES

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, NewDelhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

COURSE PLAN

Module	Contents	No. of hours
I	Morals, values and Ethics, Integrity, Academic Integrity, Work Ethics Service Learning, Civic Virtue, Respect for others, Living peacefully Caring and Sharing, Honesty, Courage, Co-operation commitment Empathy, Self Confidence, Social Expectations	6
II	Senses of Engineering Ethics, Variety of moral issues, Types of Inquiry-Moral dilemmas, Moral Autonomy, Kohlberg's theory Gilligan's theory, Consensus and Controversy, Profession& Professionalism, Models of professional roles, Theories about right action-Self-interest-Customs and Religion, Uses of Ethical Theories	6
III	Engineering as Experimentation, Engineers as responsible Experimenters-Codes of Ethics, Plagiarism, A balanced outlook on law-Challenger case study, Bhopal gas tragedy	6
IV	Collegiality and loyalty, Managing conflict, Respect for authority Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest-Occupational crime, Professional rights, Employee right, IPR, Discrimination	6
V	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics-Role in Technological Development, Moral leadership-Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	6
		30

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignments/Quiz	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20A	SUSTAINABLE ENGINEERING	MNC	2	0	0	NIL	2020

COURSE OVERVIEW

The objective of this course is to expose the students to the concept of sustainability, the global initiatives towards attaining sustainable development goals and the various sustainable practices. The students should realize the potential of technology in addressing environmental issues and bringing in sustainable solutions.

COURSE OUTCOMES

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

CO 1	Explain the relevance and the concept of sustainability and the global initiatives towards attaining sustainable development.	Understand
CO 2	Identify sustainable solutions for different types of environmental pollution problems	Apply
CO 3	Discuss the environmental regulations and standards, various tools for environmental management and clean development mechanism.	Apply
CO 4	Explain the concept of circular economy, bio-mimicking and the sustainable framework developed in industrial ecology and industrial symbiosis.	Apply
CO 5	Choose the best practice of nonconventional and sustainable energy depending on the available resources and its utilization.	Apply
CO6	Demonstrate the broad perspective of sustainable practices applicable for energy efficient buildings, green engineering, sustainable cities, sustainable urbanization, and sustainable transport.	Apply

SYLLABUS

Sustainability- need and concept, Technology and Sustainable Development, Sustainable Development Goals.
Environmental Pollution: Natural resources and their pollution, Carbon credits, Zero waste concept and 3 R concepts, Clean Development Mechanism: Carbon Trading and Carbon foot print, legal provisions for environmental protection.

Environmental management standards: ISO 14001:2015 frame work, Life Cycle Analysis, Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Resources and its utilization: Basic concepts of Conventional and non-conventional energy. Sustainability practices: Sustainable habitat, Green buildings, green materials, Sustainable urbanization.

TEXTBOOKS

1) Bradley, A.S., Adebayo A.O., Maria, P., *Engineering applications in sustainable design and development*, Cengage learning, 1st Edition, 2015.
2) Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Prentice Hall, 1st Edition, 2011
3) Purohit, S.S., *Green Technology: An Approach for Sustainable Environment*, Agrobios (India), 1st Edition, 2021.
4) Janine, M.B., *Biomimicry: Innovation Inspired by Nature,* William Morrow Paperbacks, 2002

REFERENCES

1) Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
2) ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System.

COURSE PLAN

Module	**Contents**	**No. of hours**
I	Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs).	6
II	Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Clean Development Mechanism (CDM):Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.	6
III	Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.	6

IV	Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.	6
V	Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanization, Sustainable cities, Sustainable transport.	6
	Total hours	30

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignments/Quiz/Course project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U28A	Data Structures Lab	PCC	0	0	3	2	2020

PRE-REQUISITE: ES0U10E Programming in C

COURSE OVERVIEW:

The aim of this course is to give hands-on experience in creating and using different Data Structures. It also covers various applications of linear and nonlinear Data Structures. This course helps the learners to select appropriate data structures to solve computational problems.

COURSE OUTCOMES

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

CO 1	Implement different data structures like stacks, queues, linked lists, trees and graphs efficiently.	Apply
CO 2	Apply appropriate data structures to solve problems efficiently.	Apply
CO 3	Design an efficient program to search/sort a list of records.	Apply
CO 4	Implement different hashing techniques.	Apply

SYLLABUS

Searching techniques. Stack, queue and their applications. Linked lists and its applications. Trees and its applications, Graph traversals, Different sorting techniques, Different Hashing Techniques.

REFERENCE BOOKS

1) Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C
2) Samanta D., Classic Data Structures, Prentice Hall India.
3) Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
4) Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
5) Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.

COURSE PLAN

Experiment No.	List of Exercises	No. of hours
I	Implementation of different searching techniques.	**3**
II	Implementation of stack, queue and their applications.	**9**
III	Implementation of linked lists and its applications.	**9**
IV	Implementation of trees and its applications.	**9**
V	Implementation of graph traversals.	**3**
VI	Implementation of different sorting techniques.	**6**
VII	Implementing different hashing techniques.	**6**
	Total hours	**45**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Evaluation in Lab	:	30 marks
Continuous Assessment Test	:	15 marks
Viva-voce	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U28B	Object Oriented Programming lab (in Java)	PCC	0	0	3	2	2020

PRE-REQUISITE:ES0U10E Programming in C

COURSE OVERVIEW:

The aim of the course is to provide hands-on experience to the learners on various object oriented concepts in Java Programming. The course covers implementation of object oriented concepts, packages, exception handling, multithreading, GUI based application development and database connectivity. This course helps the learners to enhance the capability to design and implement various Java applications for real world problems.

COURSE OUTCOMES

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

CO 1	Implement the Object Oriented concepts - constructors, inheritance, method overloading & overriding and polymorphism in Java.	Apply
CO 2	Implement programs in Java which use data types, operators, control statements, built in packages & interfaces, Input /Output streams and Files.	Apply
CO 3	Implement robust application programs in Java using exception handling.	Apply
CO 4	Implement application programs in Java using multithreading and database connectivity.	Apply
CO 5	Implement Graphical User Interface based application programs by utilizing event handling features and Swing in Java.	Analyze

SYLLABUS

Classes-Objects, Constructors, Data Types, Operators, Control statements, Polymorphism, Interfaces, I/O, File operations, Multithreading, Exception Handling, GUI based application programs-Swing, Database Connectivity, Searching, Sorting

REFERENCE BOOKS

1) Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2) Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
3) Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
4) Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

COURSE PLAN

Sl .No.	Topics	No. of hours
I	Basic programs using datatypes, operators, and control statements in Java.	7
II	Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism	7
III	File Handling: Problems on performing I/O operations using streams and files	8
IV	Exception handling and multi-threading applications	7
V	Graphics Programming and database connectivity	9
VI	Standard Searching and Sorting Algorithms using data structures and algorithms	7
	Total hours	**45**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Evaluation in Lab	:	30 marks
Continuous Assessment Test	:	15 marks
Viva-voce	:	15 marks

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20E	Graph Theory	BSC	3	1	0	4	2020

PRE REQUISITE: The topics covered under the course Discrete Mathematical Structures

COURSE OVERVIEW:

This course introduces fundamental concepts in Graph Theory, including properties and characterisation of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering.

COURSE OUTCOMES

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

Course Outcomes	Description	Learning Level
CO 1	Explain vertices and their properties, types of paths, classification of graphs and trees and their properties.	Understand
CO 2	Demonstrate the fundamental theorems on Eulerian and Hamiltonian graphs.	Understand
CO 3	Illustrate the working of Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's and Floyd-Warshall algorithms for finding shortest paths.	Apply
CO 4	Explain planar graphs, their properties and an application for planar graphs.	Understand
CO 5	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring.	Apply

SYLLABUS

Introduction to Graphs – Application of graphs – bipartite graphs – Incidence and Degree-Paths and circuits – Isomorphism, sub graphs, connected graphs, disconnected graphs and components.

Eulerian and Hamiltonian graphs: Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs, Digraphs and binary relation, Fleury's algorithm.

Trees and Graph Algorithms: Trees - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

Connectivity and Planar Graphs: Vertex Connectivity, Edge Connectivity, Cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem, Different representations of planar graphs, Euler's theorem, Geometric dual.

Graph Representations and Vertex Colouring: Matrix representation of graphs- Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.

TEXT BOOKS

1. Narsingh Deo, Graph theory, PHI,1979.

REFERENCES

1. R. Diestel, Graph Theory, free online edition, 2016: diestel-graph-theory.com/ basic.html.
2. Douglas B. West, Introduction to Graph Theory, Prentice Hall India Ltd.,2001
3. Robin J. Wilson, Introduction to Graph Theory, Longman Group Ltd.,2010
4. J.A. Bondy and U.S.R. Murty. Graph theory with Applications

COURSE PLAN

Module	Contents	No. of hours
I	Introduction- Basic definition – Application of graphs – finite and infinite graphs, bipartite graphs, Incidence and Degree – Isolated vertex, pendent vertex and Null graph Paths and circuits -Isomorphism -Sub graphs, walks -Paths and circuits -Connected graphs. Disconnected graphs and components	11
II	Euler graphs -Operations on graphs -Hamiltonian paths and circuits Hamiltonian paths circuits-Travelling salesman problem Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths Fleury's algorithm	11
III	Trees – properties, pendent vertex -Distance and centres in a tree Rooted and binary tree -Counting trees-Spanning trees, Fundamental circuits -Prim's algorithm-Kruskal's algorithm -Dijkstra's shortest path algorithm -Floyd-Warshall shortest path algorithm	14
IV	Vertex Connectivity, Edge Connectivity -Cut set and Cut Vertices Fundamental circuits -Planar graphs -Kuratowski's theorem Different representations of planar graphs -Euler's theorem Geometric dual	12
V	Matrix representation of graphs- Adjacency matrix, Incidence Matrix Circuit Matrix, Path Matrix -Colouring- chromatic number, Chromatic polynomial -Matching -Covering -Four colour problem and five colour problem -Four colour problem and five colour problem -Greedy colouring algorithm.	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20D	Computer Organization & Architecture	PCC	3	1	0	4	2020

PRE-REQUISITE: CS1U20B Logic System Design

COURSE OVERVIEW:

The aim of this course is to enable students to understand the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

COURSE OUTCOMES

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

CO 1	Recognize and express the relevance of basic components, I/O organization and pipelining schemes in a digital computer.	Understand
CO 2	Explain the types of memory systems and mapping functions used in memory systems.	Understand
CO 3	Demonstrate the control signals required for the execution of a given instruction.	Understand
CO 4	Illustrate the design of Arithmetic Logic Unit and explain the usage of registers in it.	Apply
CO 5	Explain the implementation aspects of arithmetic algorithms in a digital computer.	Apply
CO 6	Develop the control logic for a given arithmetic problem.	Apply

SYLLABUS

Fundamental building blocks and functional units of a computer. Memory locations and addresses. Execution phases of an instruction.

Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations. Processor logic design: - Design of arithmetic circuit, logic circuit, arithmetic logic unit, shifter, accumulator.

Arithmetic Algorithms. Pipelining: Basic principles, classification of pipeline processors, instruction and arithmetic pipelines, hazard detection and resolution.

Design of the processing unit – how arithmetic and logic operations are performed. Design of the control unit – hardwired and microprogrammed control.

I/O organisation – interrupts, DMA, different interface standards. Memory Subsystem – different types. Virtual Lab using simulation software

TEXT BOOKS

1. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization ,5/e, McGraw Hill, 2011
2. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

REFERENCES

1. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes. Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization	12
II	Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations. Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.	12
III	Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier, Booth's multiplication algorithm. Pipelining: Basic principles, classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.	12

IV	Control Logic Design: Control organization – Hardwired control-microprogram control –control of processor unit - Microprogram sequencer, micro programmed CPU organization -horizontal and vertical micro instructions.	11
V	I/O organization: accessing of I/O devices – interrupts, interrupt hardware -Direct memory access. Memory system: basic concepts – semiconductor RAMs. memory system considerations – ROMs, Content addressable memory, cache memories - mapping functions. Virtual Lab using simulation software: Design of ALU, Memory, CPU	13
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS ASSESSMENT EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20E	Database Management Systems	PCC	3	1	0	4	2020

PRE-REQUISITE: MA0U20BDiscrete Mathematical Structures

COURSE OVERVIEW:
This course provides a clear understanding of fundamental principles of Database Management Systems with special focus on relational databases to the learners. The topics covered in this course are basic concepts of DBMS in Entity Relationship (ER) model, Relational Database principles, Transaction Processing Concepts and also gives a glimpse of the alternative data management model, NoSQL. This course helps the learners to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

COURSE OUTCOMES

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

CO 1	Summarize and exemplify fundamental nature and characteristics of database systems.	Understand
CO 2	Model real world scenarios given as informal descriptions, using Entity Relationship diagrams.	Understand
CO 3	Model and design solutions for efficiently representing and querying data using relational model.	Apply
CO 4	Demonstrate the features of indexing and hashing in database applications.	Understand
CO 5	Discuss and compare the aspects of Concurrency Control and Recovery in Database systems.	Understand
CO 6	Explain various types of NoSQL databases.	Understand

SYLLABUS

Types of data, database and DBMS, Languages and users. Software Architecture, E-R Modelling, Relational Model – concepts and languages, relational algebra SQL, views, assertions and triggers, relational database design, Functional Dependency and normal forms, Secondary storage organization, Hashing, indexing, query optimization, concurrent transaction processing and recovery principles, Introduction to NoSQL.

TEXT BOOKS

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

REFERENCES

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.
3. Web Resource: https://www.w3resource.com/redis/
4. Web Resource: https://www.w3schools.in/category/mongodb/
5. Web Resource: https://www.tutorialspoint.com/cassandra/cassandra_introduction.htm
6. Web Resource: https://www.tutorialspoint.com/arangodb/index.htm

COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Database and Entity Relationship (ER) Model** Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification. ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3.	12

II	**Relational Model** Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema Introduction to Relational Algebra - select, project, Cartesian product operations, join- Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE.	12
III	**SQL and Physical Data Organization** SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non-correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types. Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Heap files, Indexing, Single level indices, numerical examples, Multi-level-indices, numerical examples, B-Trees & B+-Trees (structure only, algorithms not required), Extendible Hashing, Indexing on multiple keys – grid files.	12
IV	**Normalization** Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Code Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.	12

V	**Transactions, Concurrency Control, Recovery and Recent Topics** Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascadeless schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing. Introduction to NoSQL Databases, Main characteristics of Key-value DB (examples from: Redis), Document DB (examples from: MongoDB) , Main characteristics of Column - Family DB (examples from: Cassandra) and Graph DB (examples from : ArangoDB)	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U20F	Operating Systems	PCC	3	1	0	4	2020

PRE-REQUISITE: CS1U20A Data Structures and ES0U10EProgramming in C

COURSE OVERVIEW: Study of operating system is an essential to understand the overall working of computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operating system to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

COURSE OUTCOMES

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

CO 1	Explain the relevance, structure and functions of Operating Systems in computing devices.	Understand
CO 2	Apply the concepts of process management and process scheduling mechanisms employed in Operating Systems.	Apply
CO 3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors.	Understand
CO 4	Explain different methods for detection, prevention, avoidance and recovery for managing deadlocks in Operating Systems.	Understand
CO 5	Illustrate and examine the memory management algorithms in Operating Systems.	Apply
CO 6	Explain the security aspects and algorithms for file and storage management in Operating Systems.	Understand

SYLLABUS

Introduction: Functions of an operating system-overview. Kernel Data Structures-Operating System Interfaces and implementation - User Interfaces, System Calls. Operating System implementation and Structure, System Boot process.

Process Management, Threads, Scheduling Queues- Context Switching-Process Creation and Termination-CPU Scheduling -Inter Process Communication.

Process Synchronization, Critical Section-Synchronization – Locks, Semaphores, Monitors, Classical Problems and its implementation- Deadlocks- Handling – Prevention – Avoidance-Detection Recovery.

Memory Management-Swapping - Segmentation – Paging – Page replacement algorithms. Storage Management-RAID- Disk structure, Disk scheduling and implementation

File System Interface- Protection in Operating Systems-Directory implementation – allocation methods-Protection-Access Matrix.

TEXT BOOKS

1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.

REFERENCES

1. Andrew S Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice Hall, 2015.
2. William Stallings, “Operating systems”, 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, “Operating Systems”, 3rd Edition, Pearson Education,2016.
4. D.M. Dhamdhere, “Operating Systems”, 2nd Edition, Tata McGraw Hill, 2011.
5. Sibsankar Haldar, Alex A Aravind, “Operating Systems”, Pearson Education

COURSE PLAN

Module	Contents	No. of hours
I	Introduction: Functions of an operating system. Single processor, multiprocessor and clustered systems – overview. Kernel Data Structures Operating System Interfaces and implementation - User Interfaces, System Calls – examples. Operating System implementation - approaches. Operating System Structure – Monolithic, Layered, Micro-kernel, Modular. System Boot process.	11
II	Process Management: Process Concept – Processes-States – Process Control Block – Threads. Scheduling – Queues – Schedulers – Context Switching. Process Creation and Termination. CPU Scheduling – Scheduling Criteria – Scheduling Algorithms & implementation (P). Inter Process Communication: Shared Memory, Message Passing, Pipes	12
III	Process Synchronization: Critical Section - Peterson's solution. Synchronization – Locks, Semaphores, Monitors, Classical Problems and its implementation – Producer Consumer, Dining Philosophers and Readers-Writers Problems (P). Deadlocks – Conditions, Modeling using graphs. Handling – Prevention – Avoidance – Banker's Algorithm and its implementation (P) – Detection- Recovery.	13
IV	Memory Management: Main Memory – Swapping - fixed partitions - variable partitions - – Contiguous Memory allocation – Segmentation – Paging – Demand Paging-Page replacement algorithms. Storage Management: Overview of mass storage structure- disks and tapes. Disk structure – accessing disks. Disk scheduling and implementation (P).	12

V	File System Interface: File Concepts – Attributes – operations – types – structure – access methods. Protection. File system implementation. Directory implementation – allocation methods. Free space Management. Protection– Goals, Principles, Domain. Access Matrix.	12
	Total Hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U20A	DESIGN AND ENGINEERING	ESC	2	0	0	2	2020

PRE-REQUISITE: Nil. Its generic to all engineering disciplines.

COURSE OVERVIEW:

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are expected to apply design thinking in learning, which is very important and relevant for today. The course also focuses on familiarizing the students with the aesthetics, ergonomics and sustainability factors in designs and practice professional ethics while designing.

COURSE OUTCOMES

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

CO 1	Demonstrate the different stages involved in design engineering process	Understand
CO 2	Compose a problem statement with design objectives taking into account the customer requirements, design constraints and functionality.	Create
CO 3	Develop innovative solutions to the Design problem through brainstorming and ideation.	Apply
CO 4	Identify the concepts of Biomimicry, Aesthetics and Ergonomic factors in designs to add more value to it.	Apply
CO 5	Apply the Design communication tools to model an idea.	Apply
CO6	Incorporate different segments of knowledge in engineering in order to develop innovative, reliable, sustainable and economically viable designs.	Apply

SYLLABUS

Introduction to engineering design. Generate a design through the Design Process stages.

Design Thinking Approach, Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning.

Ideation in Design Thinking - Brainstorming sessions. Design Engineering Concepts. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability

Design Communication, Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept.

Value Engineering, Concurrent and Reverse Engineering. Expediency, Economics and Environment in Design Engineering. Design Rights. Ethics in Design.

TEXT BOOKS

1) Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, *Engineering Design Process*, Third Edition, Cengage Learning, (1 January 2017)
2) Linda C. Schmidt , George Dieter, *Engineering Design*, McGraw Hill Education; Fourth edition (1 July 2017)
3) PavanSoni, *Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving,* Penguin Random House India Private Limited, 2020
4) Voland, G., *Engineering by Design*, Pearson India 2014, Second Edition, ISBN 9332535051

REFERENCES

6) Clive L Dym, *Engineering Design: A Project Based Introduction*, Fourth Edition, John Wiley & Sons, New York 2009.
7) Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business; Revised, Updated ed. edition (5 March 2019)
8) Don Norman , *The Design of Everyday Things*, Basic Books; 2 edition (5 November 2013)
9) Dominique Forest , *Art of Things: Product Design Since 1945*, Abbeville Press Inc.,U.S.; Special edition (16 October 2014)
10) Javier Abarca, Al Bedard, et al, *Introductory Engineering Design – A Projects-Based Approach*, 3rd ed, Regents of the University of Colorado, 2000.
11) Nigel Cross, Design Thinking: *Understanding How Designers Think and Work*, Berg Publishers 2011, First Edition, ISBN: 978-1847886361
5) Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., *Engineering Design: A Systematic Approach*, Springer 2007, Third Edition, ISBN 978-1-84628-319-2.
6) George Dieter , *Engineering Design: A Materials and Processing Approach*, McGraw-Hill Education / Asia; 3 edition (16 February 2000)

COURSE PLAN

Module	Contents	No. of hours
I	Design Process: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.	3
	Practical Exercise: Need Identification. How to define a Problem Statement. Present an idea using the stages of Design Process.	3
II	Design Thinking Approach: -Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate,	4

	Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Empathize – User Persona, Day in the Life Technique, identify customer requirements using Morphological Chart and set design objectives. Define - Identifying and formulating a Problem Statement -Fish Bone Diagram	
	Practical Exercise: User Persona Chart. Morphological Chart	2
III	Ideate - Brainstorming sessions, and ideation using Random word technique, SCAMPER. Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Application of Biomimicry, Aesthetics and Ergonomics in Design. Design for X – Quality, Reliability and Sustainability.	4
	Practical Exercise: Brainstorming, 6-3-5 technique, Random Word Technique	2
IV	Design Communication: - Data Representation, Communicating Designs Orally, Graphically and in Writing. Modelling, Prototyping and Proof of Concept. Awareness of Basic tools of Design like – Autodesk, CATIA, MATLAB	3
	Practical Exercise: Communicating Designs Graphically.	4
V	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. Expediency, Economics and Environment in Design Engineering: - Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design	3
	Practical Exercise: Case Studies	2
	Total hours	30

MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Assignment/Quiz/Course project	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20B	CONSTITUTION OF INDIA	MNC	2	0	0	---	2020

PREAMBLE:

The study of the Constitution of India enables the students to

1) Understand the fundamental rights & duties and directive principles
2) Understand the functions of Executive, Legislature and Judiciary of the Union and the States
3) Understand the relation between the Union and the States
4) Provides the student the knowledge and strength to face the society and people.

PREREQUISITE: Nil

COURSE OUTCOMES:

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

CO 1	Explain the historic background of the constitution of India and its features.	Understand
CO 2	Describe the fundamental rights, duties and directive principles of state policy.	Understand
CO 3	Discuss the machinery of executive, legislature and judiciary of the Union and the States.	Understand
CO4	Explain the relation between the Union and the States.	Understand
CO 5	Demonstrate national and patriotic spirit as responsible citizens of the country.	Apply

SYLLABUS

Constitution of India: Definition, historical background, features, preamble, territory, citizenship. State, fundamental rights, directive Principles, fundamental duties. The machinery of the union government, machinery of the state governments. Statutory institutions, miscellaneous provisions, amendments to constitution.

TEXT BOOKS

1. M. Laxmikanth, Indian Polity, McGraw Hill Education India, 6/e, 2019.
2. D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi, 24/e, 2019.
3. P. M. Bhakshi, The Constitution of India, Universal Law, 14/e, 2017.

REFERENCES

1. Ministry of Law and Justice, The Constitution of India, Govt. of India, New Delhi, 2019.
2. J. N. Pandey, The Constitutional Law of India, Central Law agency, Allahabad, 51/e, 2019.
3. M. V.Pylee, India's Constitution, S. Chand and Company, New Delhi, 16/e, 2016.

COURSE PLAN

Module	Contents	No. of hours
I	Definition of constitution, historical back ground, salient features of the constitution. Preamble of the constitution, union and its territory. Meaning of citizenship, types, termination of citizenship.	4
II	Definition of state, fundamental rights, general nature, classification, right to equality, right to freedom, right against exploitation. Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences. Directive principles of state policy, classification of directives, fundamental duties.	7
III	The Union Executive, the President, the Vice President, the Council of Ministers, the Prime Minister, Attorney-General, functions. The parliament, composition, Rajyasabha, Loksabha, qualification and disqualification of membership, functions of parliament. Union judiciary, the supreme court, jurisdiction, appeal by special leave.	7
IV	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories. The State Legislature, composition, qualification and disqualification of membership, functions. The state judiciary, the high court, jurisdiction, writs jurisdiction.	6
V	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission. Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals. Official language, elections, special provisions relating	6

	to certain classes, amendments to constitution.	
	Total hours	30

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Assignment/Quiz/Course project : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U28C	Digital Lab	PCC	0	0	3	2	2020

PRE-REQUISITE: CS1U20B Logic System Design

COURSE OVERVIEW: This course aims to familiarize students with the Digital Logic Design. This course covers the implementation of logic circuits using ICs of basic logic gates and flip flops and HDL based Digital Design Flow. This course helps the learners to develop a digital logic and apply it to solve real life problems.

COURSE OUTCOMES

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

CO 1	Design and implement combinational logic circuits using logic gates	Apply
CO 2	Design and implement sequential logic circuits using Integrated Circuits	Apply
CO 3	Design and implement digital circuits using an industry compatible hardware description language	Apply

LIST OF EXPERIMENTS

Part-A

- A two-hour session should be spent to make the students comfortable with the use of trainer kit/breadboard and ICs.
- The following experiments can be conducted on breadboard or trainer kits.

1. Realization of functions using basic and universal gates (SOP and POS forms).
2. Design and realization of half adder, full adder, half subtractor and full subtractor using:
    a) basic gates (b) universal gates.
3. Design and implement 4-bit adder/subtractor circuit and BCD adder using IC7483.
4. Implementation of Flip Flops: SR, D, T, JK and Master Slave JK Flip Flops using basic gates.
5. Asynchronous Counter: Realization of Mod N counters (At least one up counter and one down counter to be implemented).
6. Synchronous Counter: Realization of Mod-N counters and sequence generators. (At least one mod N counter and one sequence generator to be implemented)

7. Realization of Shift Register (Serial input left/right shift register), Ring counter and Johnson Counter using flip flops.
8. Realization of Multiplexers and DE multiplexers using gates.
9. Realization of combinational circuits using MUX & DEMUX ICs (74150, 74154).

Part-B

- The following experiments aim at training the students in digital circuit design with Verilog. The experiments will lay a foundation for digital design with Hardware Description Languages.
- A 3-hour introductory session shall be spent to make the students aware of the fundamentals of development using Verilog.

Experiment 1. Realization of Logic Gates and Familiarization of Verilog

(a) Familiarization of the basic syntax of Verilog

(b) Development of Verilog modules for basic gates and to verify truth tables.

(c) Design and simulate the HDL code to realize three and four variable Boolean functions

Experiment 2: Half adder and full adder

(a) Development of Verilog modules for half adder in 3 modeling styles (dataflow/ structural/behavioural).

(b) Development of Verilog modules for full adder in structural modeling using half adder.

Experiment 3: Design of code converters

Design and simulate the HDL code for

(a) 4- bit binary to gray code converter

(b) 4- bit gray to binary code converter

Experiment 4: Mux and Demux in Verilog

(a) Development of Verilog modules for a 4x1 MUX.

(b) Development of Verilog modules for a 1x4 DEMUX.

Experiment 5: Flip Flops and shift registers

(a) Development of Verilog modules for SR, JK, T and D flip flops.

(b) Development of Verilog modules for a Johnson/Ring counter.

Experiment 6: Counters

(a) Development of Verilog modules for an asynchronous decade counter.

(b) Development of Verilog modules for a 3-bit synchronous up-down counter.

REFERENCE BOOKS

1) M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to the Verilog HDL,* Pearson Education, 2013.
2) T. L. Floyd, *Digital Fundamentals*, 11/e, Pearson Education, 2018.
3) S. Brownand Z. Vranesic, *Fundamentals of Digital Logic with Verilog Design*, McGraw-Hill Higher Education, 2nd edition, 2007.

COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
1	Realization of functions using basic and universal gates (SOP and POS forms).	3
2	Design and realization of half adder, full adder, half subtractor and full subtractor using basic gates and universal gates.	3
3	Design and implement 4-bit adder/subtractor circuit and BCD adder using IC7483.	3
4	Implementation of Flip Flops: SR, D, T, JK and Master Slave JK Flip Flops using basic gates.	3
5	Asynchronous Counter: Realization of Mod N counters (At least one up counter and one down counter to be implemented).	3
6	Synchronous Counter: Realization of Mod-N counters and sequence generators. (At least one mod N counter and one sequence generator to be implemented)	3
7	Realization of Shift Register (Serial input left/right shift register), Ring counter and Johnson Counter using flip flops.	3
8	Realization of Multiplexers and DE multiplexers using gates.	3
9	Realization of combinational circuits using MUX & DEMUX ICs (74150, 74154).	3
10	(a) Familiarization of the basic syntax of Verilog. (b) Development of Verilog modules for basic gates and to verify truth tables. (c) Design and simulate the HDL code to realize three and four variable Boolean functions.	3
11	(a) Development of Verilog modules for half adder in 3 modeling styles (dataflow/ structural/behavioural). (b) Development of Verilog modules for full adder in structural modeling using half adder.	3

12	Design and simulate the HDL code for (a) 4- bit binary to gray code converter (b) 4- bit gray to binary code converter	3
13	(a) Development of Verilog modules for a 4x1 MUX. (b) Development of Verilog modules for a 1x4 DEMUX.	3
14	(a) Development of Verilog modules for SR, JK, T and D flip flops. (b) Development of Verilog modules for a Johnson/Ring counter.	3
15	(a) Development of Verilog modules for an asynchronous decade counter. (b) Development of Verilog modules for a 3-bit synchronous up-down counter.	3

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Evaluation in Lab	:	30 marks
Continuous Assessment Test	:	15 marks
Viva-voce	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U28D	Operating Systems Lab	PCC	0	0	3	3	2020

PRE-REQUISITE: CS1U20AData Structures and ES0U10E Programming in C

COURSE OVERVIEW: The course aims to offer students a hands-on experience on Operating System concepts using a constructivist approach and problem-oriented learning. Operating systems are the fundamental part of every computing device to run any type of software.

COURSE OUTCOMES

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

CO 1	Illustrate the use of systems calls in Linux Operating Systems.	Apply
CO 2	Implement Process Creation and Inter Process Communication in Operating Systems.	Apply
CO 3	Implement First Come First Served, Shortest Job First, Round Robin and Priority based CPU Scheduling Algorithms.	Apply
CO 4	Illustrate the performance of First In First Out, Least Recently Used and Least Frequently Used Page Replacement Algorithms.	Apply
CO 5	Implement modules for Deadlock Detection and Deadlock Avoidance in Operating Systems.	Apply
CO 6	Implement modules for Storage Management and Disk Scheduling in Operating Systems.	Apply

SYLLABUS

Linux basic commands: directory operations, directory structure, redirection, pipes, filters, job control, changing ownership/permissions of files/links/directory - Introduction to Shell Scripting - Inter Process Communication: PIPE, Message Queue, Shared Memory - CPU scheduling algorithms: FCFS, SJF, Round Robin, Priority - producer-consumer problem - dining philosopher’s problem - First Readers-Writers Problem - Deadlock avoidance: banker’s algorithm - page replacement algorithms: FIFO, LRU, LFU - Disk scheduling algorithms: FCFS, SSTF, SCAN, C-SCAN.

REFERENCES

1) Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.

2) Andrew S Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice Hall, 2015.

3) William Stallings, “Operating systems”, 6th Edition, Pearson, Global Edition, 2015.

COURSE PLAN

SL No.	Topics	No. of hours
1	Getting started with Linux basic commands for directory operations, displaying directory structure in tree format, redirection, pipes, filters, job control, changing ownership/permissions of files/links/directory.	3
2	Introduction to Shell Scripting: Write a shell script to implement a menu driven calculator with following functions 1. Addition 2. Subtraction 3. Multiplication 4. Division 5. Modulus	6
3	Implement programs for Inter Process Communication using PIPE, Message Queue and Shared Memory.	6
4	Simulate the following non-preemptive CPU scheduling algorithms to find turnaround time and waiting time. a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority.	3
5	Implement the producer-consumer problem using semaphores.	3
6	Write a program to simulate the working of the dining philosopher’s problem.	3
7	Implement the First Readers-Writers Problem.	3
8	Implement the banker’s algorithm for deadlock avoidance.	3
9	Simulate the following page replacement algorithms a) FIFO b) LRU c) LFU	9
10	Simulate the following disk scheduling algorithms. a) FCFS b) SSTF c) SCAN d) C-SCAN	6
	Total	45

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	15 marks
Continuous Evaluation in Lab	:	30 marks
Continuous Assessment Test	:	15 marks
Viva-voce	:	15 marks

B.Tech (MINOR)

Minor Basket I: Software Engineering

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M 20A	Object Oriented Programming	Minor	3	1	0	4	2020

PRE-REQUISITE: Nil

COURSE OVERVIEW:

The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course helps the learners to develop Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

COURSE OUTCOMES

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

CO 1	Write Java programs using the object oriented concepts – classes, objects, constructors, data hiding, inheritance and polymorphism	Apply
CO 2	Utilize datatypes, operators, control statements, built in packages & interfaces, Input/ Output Streams and Files in Java to develop programs	Apply
CO 3	Illustrate how robust programs can be written in Java using exception handling mechanism	Understand
CO 4	Write application programs in Java using multithreading	Apply
CO 5	Write Graphical User Interface based application programs by utilising event handling features and Swing in Java	Apply

SYLLABUS

Introduction - Approaches to Software Design, Object Modeling using UML, Introduction to Java - JVM, Java Compiler, Bytecode.

Core Java Fundamentals – Primitive Data types, Operators, Control Statements, Object Oriented Programming in Java - Class and Object fundamentals, Constructors, Access Control, Command-line Arguments.

More features of Java – Inheritance, Packages and Interfaces, Abstract Classes and Methods, Exception Handling.

Advanced Features of Java – Input/ Output, Java Library, String Handling, Collections Framework.

GUI Programming, Event Handling and Multithreaded Programming – Swing Fundamentals, Event Handling, Multithreaded Programming.

TEXT BOOKS

1) Herbert Schildt, *Java: The Complete Reference*, 8/e, Tata McGraw Hill,2011.
2) Rajib Mall, *Fundamentals of Software Engineering*, 4th edition, PHI,2014.
3) Paul Deitel, Harvey Deitel, *Java How to Program*, Early Objects 11th Edition, Pearson, 2018.

REFERENCES

1) Y. Daniel Liang, *Introduction to Java Programming*, 7/e, Pearson,2013.
2) Nageswararao R., *Core Java: An Integrated Approach*, Dreamtech Press,2008.
3) Flanagan D., *Java in A Nutshell*, 5/e, O'Reilly,2005.
4) Barclay K., J. Savage, *Object Oriented Design with UML and Java*, Elsevier,2004.
5) Sierra K., *Head First Java*, 2/e, O'Reilly,2005.
6) Balagurusamy E., *Programming JAVA a Primer*, 5/e, McGraw Hill,2014.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction - Approaches to Software Design- Functional Oriented Design, Object-Oriented Design, Case Study of Automated Fire Alarm System. Object Modeling Using UML – Basic object oriented concepts. Basic object oriented concepts. UML diagrams, Use case model. Class diagram, Interaction diagram. Activity diagram, State chart diagram. Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode. Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues.	12
II	Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects. Object Reference, Introduction to Methods. Constructors, ***this*** Keyword. Method Overloading, Using Objects as Parameters. Returning Objects, Recursion. Access Control,	12

	static Members. Final Variables, Inner Classes. Command-Line Arguments, Variable Length Arguments.	
III	Inheritance - Super class, Sub class, the keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using final with Inheritance. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages. Interfaces. Exception Handling **-** Checked Exceptions, Unchecked Exceptions, ***try*** Block and ***catch*** Clause, Multiple ***catch*** Clauses, Nested ***try*** Statements, ***throw***, ***throws*** and ***finally.***	12
IV	Input/output - I/O Basics, Reading Console Input. Writing Console Output, PrintWriter Class. Object Streams and Serialization, Serialization, Working with Files. Working with Files. Java Library - String Handling – String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying Strings Using valueOf( ), Comparison of string Buffer and String. Collections framework – Collections overview, Collections Class – Array List. Accessing Collections via an Iterator.	12
V	Swings fundamentals, Swing Key Features. MVC, Swing Controls, Components and Containers. Exploring Swing –JFrame, JLabel, JButton, JTextField. Event handling **-** Event Handling Mechanisms, Delegation Event Model, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming- The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads.	12
	Total hours	60

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	:	10 marks
Continuous Assessment Tests	:	25 marks
Continuous Assessment Assignment	:	15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20D	Programming Methodologies	Minor	3	1	0	4	2020

PRE-REQUISITE: Nil

COURSE OVERVIEW:

The course deals with the various systems of ideas that have been used to guide the design of programming languages. It covers data types, variables, control flow structures, computational problems, characteristics of object oriented programming languages and concurrency constructs in different programming languages. The course provides the learners a clear understanding of the main constructs of contemporary programming languages.

COURSE OUTCOMES

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

CO 1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages.	Understand
CO2	Explain the characteristics of data types and variables.	Understand
CO3	Illustrate how control flow structures and subprograms help in developing the structure of a program to solve a computational problem.	Apply
CO 4	Explain the characteristics of Object Oriented Programming Languages.	Understand
CO 5	Compare concurrency constructs in different programming languages.	Understand

SYLLABUS

Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments

Data Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment.

Statement-Level Control Structures, Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Closures, Co-routines.

Support for Object Oriented Programming, Exception Handling – Basic Concepts, Design Issues. Event Handling - Introduction to Event Handling

Concurrency –– Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

TEXT BOOKS

1) Robert W. Sebesta, Concepts of Programming Languages, 10th Edition, Pearson.
2) Scott M. L., Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers.

REFERENCES

1) Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edn., Cengage Learning.
2) Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edn. –TMH.
3) Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edn., Pearson Education.
4) David A. Watt, Programming Language Design Concepts, Wiley Dreamtech.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.	11
II	Data Types- Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions- Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment-Assignment Statements, Mixed-mode Assignment.	14
III	Statement-Level Control Structures – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines.	11
IV	Support for Object Oriented Programming – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object Oriented Constructs. Exception Handling – Basic Concepts, Design Issues. Event Handling - Introduction to Event Handling.	13
V	Concurrency – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing. Functional Programming Languages – Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages.	11

	Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.	
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Minor Basket 2: Machine Learning

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20B	Python for Machine Learning	Minor	3	1	0	4	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW:

The objective of the course is to introduce Python programming and develop programming skills to manage the development of software systems. It covers Object Oriented Programming, data processing in Python and introduces to Machine Learning and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications. This course enables the learner to develop python programs and lays the foundation to develop Machine Learning and Artificial Intelligence-based applications.

COURSE OUTCOMES

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

CO 1	Write, test and debug Python programs	Apply
CO 2	Illustrate uses of conditional (if, if-else, if-else if-else and switch-case) and iterative (while and for) statements in Python programs	Apply
CO 3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python	Apply
CO 4	Implement Object Oriented programs with exception handling	Apply
CO 5	Write programs in Python to process data stored in files by utilizing the modules Numpy, Matplotlib, and Pandas	Apply

SYLLABUS

Introduction to Python and Functions-keywords, identifiers, operators, data types, statement and expression, Type conversion, reading Input, output formatting Control Flow Statements, functions and strings- conditional and Iterative statements, break and continue statements, functions and recursive functions, string methods. Data Structures in Python- list, dictionary, tuple, set Object Oriented Programming, exception handling in Python-inheritance and polymorphism, handle a single exception, handle multiple exceptions Data Processing, visualization modules in python - numpy, matplotlib, pandas.

TEXT BOOKS

1) Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2) Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers,2017

REFERENCES

1) Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
2) Michael Urban and Joel Murach, Python Programming, Shroff/Murach,2016
3) David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e,2009.
4) Charles Severance. Python for Informatics: Exploring Information,
5) http://swcarpentry.github.io/python-novice-gapminder/

COURSE PLAN

Module	Contents	No. of hours
I	Basic coding skills - Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program. Input, Processing, and Output. Formatting output. Detecting and correcting syntax errors. Using built in functions and modules in math module	10
II	Control statements - Selection structure (if-else, switch-case), Iteration structure (for, while), Testing the control statements, Lazy evaluation. Functions - Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions. Strings and number systems - String function, Handling numbers in various formats.	13
III	Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries – Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries.	12
IV	Design with classes - Objects and Classes, Methods, Instance Variables, Constructor, Accessors and Mutators. Structuring classes with Inheritance and Polymorphism. Abstract Classes.	11

	Exceptions - Handle a single exception, handle multiple exceptions.	
V	The os and sys modules. NumPy - Basics, creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization using Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files with Pandas - Reading, Manipulating, and Processing Data.	14
	Total hours (Approx.)	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20E	Mathematics for Machine Learning	Minor	3	1	0	4	2020

COURSE OVERVIEW: This is the foundational course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in Machine Learning. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

Prerequisite: CS0M20B Python for Machine Learning

COURSE OUTCOMES

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

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems	Apply
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients	Apply
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems	Apply
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods	Apply

SYLLABUS

Linear Algebra: Systems of Linear Equations, Matrices**, ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS:** Norms, Eigen decomposition and Diagonalization, **Vector Calculus:** differentiation of Univariate Functions, Useful Identities for Computing Gradients**, Probability and Distributions:** Data and Learning Model Empirical Risk Minimization**,** Summary Statistics and Independence, **Optimization**: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

TEXT BOOKS

1) Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https://mml - book.github.io)

REFERENCES

1) Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2) Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer
3) Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press

COURSE PLAN

Module	**Contents**	**No. of hours**
I	**LINEAR ALGEBRA:** Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.	14
II	**ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS:** Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	14
III	**VECTOR CALCULUS:** Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives Linearization and Multivariate Taylor Series.	10
IV	**Probability and Distributions:** Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.	12

V	**Optimization:** Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming	10
	Total hours (Approx.)	60

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Minor Basket 3: Networking

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20C	Data Communication	MINOR	3	1	0	4	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: The purpose of this course is to prepare learners to understand the communication entities and the associated issues in the field of Computer Science. This course covers fundamental concepts of data transmission &media, digital & analog transmissions, multiplexing & spread spectrum, error detection &correction and switching. Concepts in data communication help the learner to understand the concepts in networking and mobile communication.

COURSE OUTCOMES

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

CO 1	Describe the characteristics of signals used for Analog and Digital Transmissions	Understand
CO 2	Discuss the features and issues in data transmission	Understand
CO 3	Select transmission media based on characteristics and propagation modes	Apply
CO 4	Apply appropriate signal encoding techniques for a given scenario	Apply
CO 5	Illustrate multiplexing and spread spectrum technologies	Understand
CO 6	Explain error detection & correction techniques and switching techniques used in data communication	Understand

SYLLABUS

Data Transmission Basics - Communication model - Periodic Analog signals - Analog & digital data and signals - Transmission Impairments-Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.

Transmission Media - Guided Transmission Media - Unguided media -Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.

Digital Transmission and Analog Transmission - Digital data to Digital signal - Analog data to Digital signal - Digital data to Analog signal - Analog data to Analog signal.

Multiplexing and Spread Spectrum - Multiplexing - FDM, WDM, TDM, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - DSSS, FHSS, CDM, CDMA.

Error Detection, Correction and Switching - Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors- Detection Methods - Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.

TEXT BOOKS

1) Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.
2) William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

REFERENCES

1) Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2) Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

COURSE PLAN

Module	Contents	No. of hours
I	**Data Transmission Basics** Communication model - Simplex, Half duplex, Full duplex transmission. Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.	12
II	Transmission Media Guided Transmission Media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.	12
III	Digital Transmission and Analog Transmission Digital data to Digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel binary, Biphase. Analog data to Digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to Analog signal: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). Analog data to Analog signal: Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).	12

IV	Multiplexing and Spread Spectrum Multiplexing - Frequency Division Multiplexing (FDM), Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	12
V	Error Detection, Correction and Switching Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming Distance, Hamming Code. Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.	12
	Total Hours	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20F	Introduction to Computer Networks	Minor	3	1	0	4	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: The aim of this course is to build an understanding of the fundamental concepts of computer networking. The course covers the main features of computer networks, various protocols, routing algorithms and its functions. The learner will be able to familiarize the basic protocols of computer networks, and how they can be used to assist in computer design and implementation.

COURSE OUTCOMES

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

CO 1	Explain the features of computer networks, protocols and network design models	Understand
CO 2	Summarize the design issues of data link layer, data link layer protocols, bridges and switches	Understand
CO 3	Illustrate wired LAN protocols (IEEE 802.3/4/5) and wireless LAN protocols (IEEE 802.11a/b/g/n, 802.15)	Understand
CO 4	Choose appropriate routing algorithms, congestion control techniques and Quality of Service parameters for a network	Apply
CO 5	Illustrate the functions and protocols of network, transport and application layer in inter-networking	Understand

SYLLABUS

Introduction-Uses of Computer Networks, Network Hardware, Network Software, Reference Models.

The Data Link Layer - Data Link layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols. The Medium Access Control (MAC) Sub layer - Ethernet, Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.

Network Layer Design Issues. Routing Algorithms, Routing for Mobile Hosts, Congestion Control Algorithms, Quality of Service (QoS).

Network Layer in Internet-ICMP, IP, ARP, RARP, BOOTP, DHCP, OSPF, IPV6.

Transport Layer – The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives, The User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Application Layer protocols.

TEXT BOOKS

1) Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).

REFERENCES

1) Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill .
2) William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
3) James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction – Uses of Computer Networks, Network Hardware, Network Software, Reference Models – The OSI Reference Model, The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models.	12
II	The Data Link Layer - Data Link layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols, Sliding Window Protocols, HDLC (High-Level Data Link Control) Protocol. The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.	13
III	Network Layer Design Issues. Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast Routing, Routing for Mobile Hosts. Congestion Control Algorithms, Quality of Service (QoS) - Requirements, Techniques for Achieving Good QoS	11
IV	Network Layer in Internet – The IP Protocol, IP Addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First (OSPF) Protocol, Border Gateway Protocol (BGP), Internet Multicasting, IPv6, ICMPv6.	12

V	Transport Layer – The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP), Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling, TCP Retransmission Policy, TCP Congestion Control. Application Layer – File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, MIME, Simple Network Management Protocol (SNMP), Dynamic Host Configuration Protocol (DHCP), World Wide Web – Architectural Overview.	12
	Total Hours	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

B.Tech (HONOURS)

Honour Bucket 1: Security in Computing

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H20A	NUMBER THEORY	Honours	3	1	0	4	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: The aim of this course is to create awareness among learners about the important areas of number theory used in computer science. The course covers modular arithmetic operations, methods to verify correctness of mathematical assertions, theorems for ensuring security in computing systems and applications of arithmetic functions. The goal of the course is to help the learners to apply the concepts in practical applications of Computer organization and Security, Coding and Cryptography, Random number generation, Hash functions and Graphics.

COURSE OUTCOMES

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

CO 1	Illustrate modular arithmetic operations, methods and techniques	Understand
CO 2	Use the methods - Induction, Contraposition or Contradiction to verify the correctness of mathematical assertions	Apply
CO 3	Utilize theorems and results about prime numbers, congruences, quadratic residues and integer factorization for ensuring security in computing systems.	Analyse
CO 4	Illustrate uses of Chinese Remainder Theorem & Euclidean algorithm in Cryptography and Security	Apply
CO 5	Explain applications of arithmetic functions in Computer Science	Understand
CO 6	Implement Number Theoretic Algorithms using a programming language	Apply

SYLLABUS

Divisibility and Modular Arithmetic, Finite Fields, Divisibility and Division Algorithms, Modular Arithmetic- Properties, Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm, LCM.

Primes and Congruence, Methods to find prime numbers, Primality testing and factorization, Congruence, Chinese Remainder Theorem, Fermat's little theorem, Wilson's theorem.

Congruences with a Prime-Power Modulus, Pseudo-primes and Carmichael numbers, Euler's Function, Euler's Totient function, Applications of Euler's Totient function, The Group of units-The group U_n, primitive roots.

Quadratic Residues, Quadratic Congruences, Legendre symbol, Jacobi Symbol, Quadratic reciprocity. Arithmetic Functions, Arithmetic Functions, Perfect numbers, Mobius function. The Dirichlet Products.

Sum of Squares, The Gaussian Integers, Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.

TEXT BOOKS

1) G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.
2) Joseph Silverman, A Friendly introduction to Number Theory, Pearson Ed. 2009.

REFERENCES

1) William Stallings, Cryptography and Network Security Principles and Practice, Pearson Ed.
2) Tom M.Apostol, 'Introduction to Analytic Number Theory', Narosa Publishing House Pvt. Ltd, New Delhi, (1996).
3) Neal Koblitz, A course in Number Theory and Cryptography, 2nd Edition, Springer ,2004.

COURSE PLAN

Module	Contents	No. of hours
I	**Divisibility and Modular Arithmetic:** Finite Fields – Groups, Rings and Fields. Divisibility - Divisibility and Division Algorithms, Well ordering Principle, Bezout's Identity. Modular Arithmetic- Properties, Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm, Least Common multiple, Solving Linear Diophantine Equations, Modular Division.	12
II	**Primes and Congruence:** Prime Numbers-Prime Numbers and prime – power factorization, Fermat and Mersenne primes, Primality testing and factorization. Congruences- Linear congruences, Simultaneous linear congruences, Chinese Remainder Theorem, Fermat's little theorem, Wilson's theorem.	12
III	**Congruences with a Prime-Power Modulus & Euler's Function:** Congruences with a Prime-Power Modulus-Arithmetic modulo p, Pseudo-primes and Carmichael numbers, Solving congruences modulo prime powers. Euler's Function-Euler's Totient function, Applications of Euler's Totient function, Traditional Cryptosystem, Limitations. The Group of units- The group U_n, primitive roots, Existence of primitive roots, Applications of primitive roots.	12
IV	**Quadratic Residues & Arithmetic Functions:** Quadratic Residues- Quadratic Congruences, The group of Quadratic residues, Legendre symbol, Jacobi Symbol, Quadratic reciprocity. Arithmetic Functions- Definition and examples, Perfect numbers, Mobius function and its properties, Mobius inversion formula, The Dirichlet Products.	12
V	**Sum of Squares and Continued Fractions:** Sum of Squares- Sum of two squares, The Gaussian Integers, Sum of three squares, Sum of four squares. Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.	12
	Total hours (Approx.)	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Honour Bucket 2: Machine Learning

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H20B	Computational Fundamentals of Machine Learning	Honour	3	1	0	4	2020

PRE-REQUISITE: Nil

COURSE OVERVIEW: This is the foundational course for awarding B. Tech. Honours in Computer Science and Engineering with specialization in Machine Learning. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

COURSE OUTCOMES

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

CO 1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems	Apply
CO 2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients	Apply
CO 3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems	Apply
CO 4	Train Machine Learning Models using unconstrained and constrained optimization methods	Apply

SYLLABUS

Linear Algebra: Systems of Linear Equations, Matrices**, ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS:** Norms, Eigen decomposition and Diagonalization, **Vector Calculus:** differentiation of Univariate Functions, Useful Identities for Computing Gradients**, Probability and Distributions:** Data and Learning Model Empirical Risk Minimization**,** Summary Statistics and Independence, **Optimization**: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

TEXT BOOKS

1) Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https://mml - book.github.io)

REFERENCES

4) Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
5) Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer
6) Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press

COURSE PLAN

Module	Contents	No. of hours
I	**LINEAR ALGEBRA:** Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.	14
II	**ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS:** Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	14
III	**VECTOR CALCULUS:** Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives Linearization and Multivariate Taylor Series.	10

IV	**Probability and Distributions:** Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.	12
V	**Optimization:** Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming	10
Total hours (Approx.)		60

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

Honour Bucket 3: Formal Methods

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H20C	PRINCIPLES OF PROGRAM ANALYSIS AND VERIFICATION	Honour	3	1	0	4	2020

PRE-REQUISITE: MA0U20BDiscrete Mathematical Structures

COURSE OVERVIEW: The goal of this course is to introduce the Methods, Technologies and Tools employed to ensure reliability and correctness of software systems.

COURSE OUTCOMES

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

CO 1	Explain the concepts of Lattices, Chains, Fixed Points, Galois Connections, Monotone and Distributive Frameworks, Hoare Triples, Weakest Preconditions, Loop Invariants, and specify Verification Conditions to perform Analysis and Verification of programs.	Understand
CO 2	Apply method for doing intraprocedural / inter procedural Dataflow Analysis for a given Program Analysis Problem.	Analyse
CO 3	Formulate an Abstract Interpretation framework for a given dataflow analysis problem and do the analysis using the Tool WALA.	Analyse
CO 4	Apply Kildall's Algorithm to do Abstract Interpretation of Programs, and compare the results obtained by the Algorithm on Monotone and Distributive Frameworks.	Apply
CO 5	Explain the concept of Loop Invariants and use them in Hoare Triple based Weakest Precondition analysis to verify the total correctness of a code segment.	Apply
CO 6	Analyse the correctness of a given C Program with respect to a given set of properties to be satisfied by the program.	Analyse

SYLLABUS

Mathematical Foundations- Introduction to Program Analysis–Intraprocedural Data Flow Analysis – Interprocedural Data Flow Analysis - Abstract Interpretation - Program Verification

TEXT BOOKS

1) Flemming Nielson, Henne Nielson and Chris Kankin, *Principles of Program Analysis*, Springer, 1999.

2) Michael Hutch and Mark Ryan, *Logic in Computer Science –Modeling and Reasoning about Systems,* Cambridge University Press, Second Edition.

REFERENCES

1) Julian Dolby and Manu Sridharan, *Core WALA Tutorial (PLDI 2010),* available online athttp://wala.sourceforge.net/files/PLDI_WALA_Tutorial.pdf
2) Ernie &Hillebrand, Mark & Tobies, Stephan. (2012). *Verifying C Programs: A VCC Tutorial*.

COURSE PLAN

Module	Contents	No. of hours
I	Partially Ordered Set, Complete Lattice, Construction of Complete Lattices, Chains, Fixed Points, Knaster-Tarski Fixed Point Theorem.	9
II	The WHILE language, Data Flow Analysis, Reaching Definition Analysis, Abstract Interpretation, Algorithm to find the least solutions for the Data Flow Analysis problem.	11
III	Available Expressions Analysis, Reaching Definitions Analysis, Very Busy Expressions Analysis, Live Variable Analysis, Derived Data Flow Information, Monotone and Distributive Frameworks, Equation Solving –MFP and MOP solution, Structural Operational Semantics, Intraprocedural versus Interprocedural Analysis, Making Context Explicit, Call Strings as Context, Flow Sensitivity versus Flow Insensitivity. Implementing Interprocedural Dataflow Analysis using the Tool WALA.	15
IV	A Mundane Approach to Correctness, Approximations of Fixed Points, Galois Connections, Systematic Design of Galois Connections, Induced Operations, Kildall’s Algorithm for Abstract Interpretation.	11

V	Why should we Specify and Verify Code, A framework for software verification – A core programming Language, Hoare Triples, Partial and Total Correctness, Program Variables and Logical Variables, Proof Calculus for Partial Correctness, Loop Invariants, Verifying C Programs in VCC- the annotation language, the verification methodology, and the use of VCC.	14
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Assignment : 15 marks

SEMESTER V

CS1U30A	FORMAL LANGUAGES AND AUTOMATA THEORY	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2020

PRE-REQUISITE: Nil

COURSE OVERVIEW: This is a core course in theoretical computer science. It covers automata and grammar representations for languages in Chomsky Hierarchy. For regular languages, it also covers representations using regular expression and Myhill-Nerode Relation. The topics covered in this course have applications in various domains including compiler design, decidability and complexity theory, software testing, formal modelling and verification of hardware and software.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable. **[Cognitive knowledge level: Understand]**
CO2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation. [**Cognitive knowledge level: Understand**]
CO3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language. [**Cognitive knowledge level** : **Apply**]
CO4	Design Turing machines as language acceptors or transducers. [**Cognitive knowledge level: Apply]**
CO5	Explain the notion of decidability. [**Cognitive knowledge level: Understand]**

SYLLABUS

Introduction to Automata Theory, Structure of an automaton, classification of automata, grammar and automata for generating each class of formal languages in the Chomsky Hierarchy, decidability and Halting problem.

TEXT BOOKS

1. Dexter C. Kozen, Automata and Computability, Springer (1999).

REFERENCE MATERIALS

1) John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages and Computation, 3/e Pearson Education, 2007.
2) Michael Sipser, Introduction to Theory of Computation, Cengage Publishers, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to formal language theory– Alphabets, Strings, Concatenation of strings, Languages. Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required), Nondeterministic Finite State Automata (NFA), Equivalence of DFA and NFA**,** Regular Grammar (RG), Equivalence of RGs and DFA.	13
II	More on Regular Languages Regular Expression (RE), Equivalence of REs and DFA, Homomorphisms, Necessary conditions for regular languages, Closure Properties of Regular Languages, DFA state minimization (No proof required)	12
III	Myhill-Nerode Relations and Context Free Grammars Myhill-Nerode Relations (MNR)- MNR for regular languages, Myhill-Nerode Theorem (MNT) (No proof required), Applications of MNT. Context Free Grammar (CFG)- CFG representation of Context Free Languages (proof of correctness is required), derivation trees and ambiguity, Normal forms for CFGs.	11
IV	More on Context-Free Languages Nondeterministic Pushdown Automata (PDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required), Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.	12
V	Context Sensitive Languages, Turing Machines Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata.	12

	Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.	
	Total hours	**60**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1U30B	COMPUTER NETWORKS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2020

PRE-REQUISITE :Nil

COURSE OVERVIEW: Study of this course provides the learners a clear understanding of how computer networks from local area networks to the massive and global Internet are built, how they allow computers to share information and communicate with one another. This course covers the physical aspects of computer networks, layers of OSI Reference model, and inter-networking. The course helps the learners to compare and analyse the existing network technologies and choose a suitable network design for a given system.

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

CO1	Explain the features of computer networks, protocols, and network design models **(Cognitive Knowledge: Understand)**
CO2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication **(Cognitive Knowledge: Apply)**
CO3	Explain the design issues of data link layer, link layer protocols, bridges and switches **(Cognitive Knowledge: Understand)**
CO4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11) **(Cognitive Knowledge: Understand)**
CO5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network **(Cognitive Knowledge: Apply)**
CO6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking **(Cognitive Knowledge: Understand)**

SYLLABUS

Introduction-Reference models-Physical Layer-Data link layer - Medium Access Control (MAC) sublayer - Wireless LANs - 802.11 -Network layer - Routing Algorithms- Congestion Control Algorithms- Quality of Service (QoS)- Network Layer in Internet--Transport Layer – User Datagram Protocol (UDP)- Transmission Control Protocol (TCP) – Application Layer protocols.

TEXT BOOKS

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill.

REFERENCE MATERIALS

1. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.
2. Fred Halsall, Computer Networking and the Internet, 5/e.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e.
4. Keshav, An Engineering Approach to Computer Networks, Addison Wesley, 1998.
5. W. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley, 2005.
6. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.
7. Request for Comments (RFC) Pages - IETF -https://www.ietf.org/rfc.html.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer – Modes of communication, Physical topologies, Signal encoding, Repeaters and hub, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product.	12
II	Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Bridges & switches - Bridges from 802.x to 802.y, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.	13

III	Network layer design issues. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms. Quality of Service (QoS) - requirements, Techniques for achieving good QoS.	12
IV	IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First(OSPF) Protocol, Border Gateway Protocol (BGP), Internet multicasting, IPv6, ICMPv6.	11
V	Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment &release, Connection management modeling, TCP retransmission policy, TCP congestion control. Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol (SNMP), World Wide Web(WWW) – Architectural overview.	12

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS1U30C	SYSTEM SOFTWARE	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2020

PRE-REQUISITE:CS1U20A Data Structures and CS1U20D Computer Organization & Architecture.

COURSE OVERVIEW

The purpose of this course is to create awareness about the low-level codes which are very close to the hardware and about the environment where programs can be developed and executed. This course helps the learner to understand the machine dependent and machine independent system software features and to design/implement system software like assembler, loader, linker, macroprocessor and device drivers. Study of system software develops the ability to design interfaces between software applications and computer hardware**.**

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Distinguish **softwares** into system and application software categories. **(Cognitive Knowledge Level: Understand)**
CO2	Identify **standard** and extended architectural features of machines. (**Cognitive Knowledge Level: Apply)**
CO3	Identify machine dependent features of system software (**Cognitive Knowledge Level: Apply)**
CO4	Identify machine independent features of system software. (**Cognitive Knowledge Level: Understand)**
CO5	Design **algorithms** for system softwares and analyze the effect of data structures. (**Cognitive Knowledge Level: Apply)**
CO6	Explain the features of device drivers and editing & debugging tools.(**Cognitive Knowledge Level: Understand)**

SYLLABUS

Different types of System Software, Architecture, Instruction set, Assembler Directives and addressing modes of SIC and SIC/XE. Basic functions, Algorithms and Data Structures of Assembler. Machine dependent assembler features, Hand Assembly of SIC/XE Programs, Machine independent Assembler Features, Assembler Design Options, Implementation Example-MASM. Basic Loader Functions, Machine Dependent Loader Features, Machine Independent Loader Features, Loader Design Options. One pass Macro processor Algorithm and data structures, Machine Independent Macro Processor Features, Macro processor design options. Device drivers, Text Editors and Debuggers.

TEXT BOOKS

1. Leland L. Beck, System Software: An Introduction to Systems Programming, 3/E, Pearson Education Asia

REFERENCE MATERIALS

1. D.M. Dhamdhere, Systems Programming and Operating Systems, Second Revised Edition, Tata McGraw Hill.
2. John J. Donovan, Systems Programming, Tata McGraw Hill Edition 1991.
3. George Pajari, Writing UNIX Device Drivers, Addison Wesley Publications (Ebook : http://tocs.ulb.tu-darmstadt.de/197262074.pdf).
4. Peter Abel, IBM PC Assembly Language and Programming, Third Edition, Prentice Hall of India.
5. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device Drivers, Third Edition, O.Reilly Books
6. M. Beck, H. Bohme, M. Dziadzka, et al., Linux Kernel Internals, Second Edition, Addison Wesley Publications,
7. J Nithyashri, System Software, Second Edition, Tata McGraw Hill.
8. The C Preprocessorhttp://gcc.gnu.org/onlinedocs/gcc-2.95.3/cpp_1.html

COURSE PLAN

Module	Contents	No. of hours
I	System Software vs Application Software, Different System Software– Assembler, Linker, Loader, Macro Processor, Text Editor, Debugger, Device Driver, Compiler, Interpreter, Operating System (Basic Concepts only). SIC & SIC/XE Architecture, Addressing modes, SIC & SIC/XE Instruction set, Assembler Directives.	11
II	SIC/XE Programming, Basic Functions of Assembler, Assembler Output Format – Header, Text and End Records. Assembler Data	12

	Structures, Two Pass Assembler Algorithm, Hand Assembly of SIC/XE Programs.	
III	Machine Dependent Assembler Features-Instruction Format and Addressing Modes, Program Relocation. Machine Independent Assembler Features –Literals, Symbol Defining Statements, Expressions, Program Blocks, Control Sections and Program Linking. Assembler Design Options- One Pass Assembler, Multi Pass Assembler. Implementation Example-MASM Assembler.	12
IV	Basic Loader Functions - Design of Absolute Loader, Simple Bootstrap Loader. Machine Dependent Loader Features- Relocation, Program Linking, Algorithm and Data Structures of Two Pass Linking Loader. Machine Independent Loader Features -Automatic Library Search, Loader Options. Loader Design Options.	12
V	Macro Preprocessor - Macro Instruction Definition and Expansion, One pass Macro processor Algorithm and data structures, Machine Independent Macro Processor Features, Macro processor design options. Device drivers - Anatomy of a device driver, Character and block device drivers, General design of device drivers. Text Editors- Overview of Editing, User Interface, Editor structure. Debuggers- Debugging functions and capabilities, Relationship with other parts of the system, Debugging methods- By Induction, Deduction and Backtracking.	13

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS1U30D	MICROPROCESSORS AND MICROCONTROLLERS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2020

PRE-REQUISITE: CS1U20B Logic System Design and CS1U20D Computer organization &Architecture

COURSE OVERVIEW: The course enables the learners capable of understanding the fundamental architecture of microprocessors and micro controllers. This course focuses on the architecture, assembly language programming, interrupts, interfacing of microprocessors with peripheral devices and microcontrollers and its programming. It helps the learners to extend the study of latest processors and develop hardware based solutions.

COURSE OUTCOMES

CO1	Illustrate the **architecture**, modes of operation and addressing modes of microprocessors **(Cognitive knowledge: Understand)**
CO2	Develop 8086 **assembly** language programs. **(Cognitive Knowledge Level: Apply**)
CO3	Demonstrate interrupts, its **handling** and programming in 8086. **(Cognitive Knowledge Level: Apply**))
CO4	Illustrate how different **peripherals**(8255,8254,8257) and memory are interfaced with microprocessors. (**Cognitive Knowledge Level: Understand**)
CO5	Outline features of **microcontrollers** and develop low level programs. **(Cognitive Knowledge Level: Understand)**

SYLLABUS

8085 microprocessor- Architecture, 8086 microprocessor- architecture, memory organization, addressing modes, instruction set, assembly language programming.

8086 - Stack structure, interrupt handling, types of interrupts, 8259 Programmable Interrupt Controller interfacing with 8086.

8255 Programmable Peripheral Input/output port Architecture and modes of operation, 8254 and 8257 architecture.

8051 microcontroller architecture, memory organization, interrupts and stack, addressing modes, instruction set, sample programs.

TEXT BOOKS

1. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill.

2. Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Pearson Education.
3. Ramesh Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, Penram International Publishing Pvt. Ltd.

REFERENCE MATERIALS

1. Barry B. Brey, The Intel Microprocessors – Architecture, Programming and Interfacing, Eighth Edition, Pearson Education.
2. A. NagoorKani, Microprocessors and Microcontrollers, Second Edition, Tata McGraw Hill
3. Douglas V. Hall, SSSP Rao, Microprocessors and Interfacing, Third Edition, McGrawHill Education.

COURSE PLAN

Module	Contents	No. of hours
I	8085 microprocessor (-Basic Architecture only). 8086 microprocessor – Architecture and signals, Physical Memory organization, Minimum and maximum mode of 8086 system and timings. Comparison of 8086 and 8088.Machine language Instruction format.	**10**
II	Addressing Modes of 8086. Instruction set – data copy /transfer instructions, arithmetic instructions, logical instructions, string manipulation instructions, branch instructions, unconditional and conditional branch instruction, flag manipulation and processor control instructions. Assembler Directives and operators. Assembly Language Programming with 8086.	**13**
III	Stack structure of 8086, programming using stack- Interrupts - Types of Interrupts and Interrupt Service Routine- Handling Interrupts in 8086- Interrupt programming. - Programmable Interrupt Controller - 8259, Architecture (Just mention the control word, no need to memorize the control word)- Interfacing Memory with 8086	**10**
IV	Programmable Peripheral Input/output port 8255 - Architecture and modes of operation- Programmable interval timer 8254-Architecture and modes of operation- DMA controller 8257 Architecture (Just mention the control word, no need to memorize the control word of 8254 and 8257)	**13**
V	8051 Architecture- Register Organization- Memory and I/O addressing- Interrupts and Stack- 8051 Addressing Modes- Instruction Set- data transfer instructions, arithmetic	**13**

	instructions, logical instructions, Boolean instructions, control transfer instructions- Simple programs	

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1U30E	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2020

PRE-REQUISITE: CS1U20C Object Oriented Programming using Java.

COURSE OVERVIEW: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance, Project Management concepts and technology trends. This course enables the learners to apply state of the art industry practices in Software development.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Demonstrate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Apply)**
CO2	Prepare Software Requirement Specification and Software Design for a given problem. **(Cognitive Knowledge Level**: **Apply**)
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with a traditional/agile framework**. (Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices. **(Cognitive Knowledge Level: Apply**)

SYLLABUS

Introduction to Software Engineering-Software process models- Process activities - Agile software development-case studies: An insulin pump control system. Mentcare - a patient information system for mental health care. Functional and non-functional requirements-Requirements engineering processes. Software Requirements Specification- Template - Design Concepts-Architectural Design - What is a component? - Designing Class-Based Components, Conducting Component level design, Component level design for web-apps-Object-oriented design using the UML-Review Techniques -Software testing strategies-Test automation-Overview of DevOps and Code Management-Software Evolution - Evolution processes, Software maintenance. Software Project Management - Risk management-Project Planning - Project scheduling - Configuration management - Software Quality- Software Process Improvement(SPI) - Cloud-based Software - Software as service.

TEXT BOOKS

1. Book 1 - Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Book 2 - Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Book 3 - Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

REFERENCE MATERIALS

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design—Software Design Descriptions
3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. HenricoDolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto - values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.	**9**
II	Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions". Case study: The Ariane 5 launcher failure.	**10**
III	Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, Continuous Integration, Delivery, and Deployment	**11**

	(CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.	
IV	Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.	**8**
V	Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks , Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software. Cloud-based Software - Virtualisation and containers, Everything as a service (IaaS, PaaS), Software as a service. Microservices Architecture -Microservices, Microservices architecture, Microservice deployment.	**7**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

(Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

<table>
<tr><td rowspan="2">NC0U30A</td><td rowspan="2">DISASTER MANAGEMENT</td><td>Catego ry</td><td>L</td><td>T</td><td>P</td><td>Cred it</td><td>Year of Introduction</td></tr>
<tr><td>MNC</td><td>2</td><td>0</td><td>0</td><td>Nil</td><td>2020</td></tr>
</table>

PRE-REQUISITE: Nil

COURSE OVERVIEW:

The goal of this course is to expose the students to the fundamental concepts of hazards and disaster management. The course details the various phases of disaster risk management and the measures to reduce disaster risks.

COURSE OUTCOMES

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

CO 1	Explain the fundamental concepts and terminology related to disaster management cycle	Understand
CO 2	Explain hazard and vulnerability types and disaster risk assessment	Understand
CO 3	Describe the process of risk assessment and appropriate methodologies to assess risk	Understand
CO 4	Explain the core elements and phases of disaster risk management and measures to reduce disaster risks across sector and community	Apply
CO 5	Discuss the factors that determine the nature of disaster response and the various disaster response actions	Understand
CO 6	Explain the legislations and best practices for disaster management and risk reduction at national and international level	Understand

SYLLABUS

Introduction- Systems of Earth, Key concepts and terminology in disaster risk reduction and management

Hazard types, Vulnerability types and their assessment, Disaster risk assessment

Disaster risk management- Phases of disaster risk management, Measures for disaster risk reduction- prevention, mitigation, preparedness, Disaster response, Relief

Participatory stakeholder engagement, Disaster communication, Capacity building

Common disaster types in India, Legislations in India on Disaster Management, National Disaster Management Policy, Institutional arrangements for disaster management in India, The Sendai Framework for Disaster risk reduction.

TEXT BOOKS

1. Coppola, D.P., *Introduction to International Disaster Management*, Elsevier Science (B/H), London, 2020
2. Srivastava, H.N., Gupta, G.D., *Management of Natural Disasters in developing countries*, Daya Publishers, Delhi, 2007
3. Subramanian, R., *Disaster Management*, Vikas Publishing House, 2018
4. Sulphey, M.M., Disaster *Management*, PHI Learning, 2016

REFERENCE MATERIALS

1. NDMA, National Policy on Disaster Management, Ministry of Home Affairs, Government of India,2009.
2. National Disaster Management Division, Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi,2004.
3. National Disaster Management Plan, NDMA, Ministry of Home Affairs, Government of India,2019.
4. Disaster Management Training Manual, UNDP, 2016
5. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

COURSE PLAN

Module	Contents	No. of hours
I	Introduction about various systems of earth, Lithosphere-composition, rocks, soils; Atmosphere- layers, ozone layer, greenhouse effect. Weather, cyclones, atmospheric circulations, Indian monsoon; Hydrosphere- oceans, inland water bodies; Biosphere Definition and meaning of key terms in Disaster risk reduction and Management – disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster	6

	preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment	
II	Various hazard types, hazard mapping; Different types of vulnerability types and their assessment- Physical, social, economic and environmental vulnerability. Core elements of disaster risk assessment Components of a comprehensive disaster preparedness strategy approaches, procedures Different disaster response actions	6
III	Introduction to disaster risk management, core elements of disaster risk management Phases of disaster risk management, Measures for disaster risk reduction Measures for disaster prevention, mitigation, and preparedness Disaster response- objectives, requirements. Disaster response planning; types of responses Disaster relief, International relief organisations	7
IV	Participatory stakeholder engagement, Importance of disaster communication, Disaster communication- methods, barriers, Crisis counselling Introduction to capacity building, Concept- Structural measures, Non-structural measures Introduction to Capacity assessment, Capacity assessment- Strengthening, Capacity for reducing risk	5
V	Introduction- common disaster types in India Common disaster legislations in India on disaster management National disaster management policy, Institutional arrangements for disaster management in India. The Sendai Framework for Disaster risk reduction and targets-priorities for action, guiding principles	6
	Total hours	30

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS1U38A	**SYSTEM SOFTWARE AND MICROPROCESSORS LAB**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		PCC	**0**	**0**	**4**	**2**	**2020**

PRE-REQUISITE: CS1U20F Operating systems.

COURSE OVERVIEW: The aim of this course is to give hands-on experience in how microcontrollers, and microprocessors can be programmed. The course also aims to enable students to design and implement system software. The student should get familiar with assembly level programming of microprocessors and microcontrollers, interfacing of devices to microcontrollers, resource allocation algorithms in operating systems and design and implementation of system software.

COURSE OUTCOMES

CO1	Develop 8086 and 8051 programs and execute it using a microprocessor and microcontroller kit respectively. **(Cognitive Knowledge Level: Apply) .**
CO2	Develop 8086 programs and, debug and execute it using MASM assemblers **(Cognitive Knowledge Level: Apply)**
CO3	Develop and execute programs to interface stepper motor, 8255, 8279 and digital to analog converters with 8086 trainer kit **(Cognitive Knowledge Level:Apply)**
CO4	Implement and execute different paging and file management techniques in OS. **(Cognitive Knowledge Level: Apply)**
CO5	Design and implement assemblers, Loaders and macroprocessors. **(Cognitive Knowledge Level: Apply)**

SYLLABUS

MICROPROCESSOR LAB

1. Assembly Language Programming Exercises/Experiments using 8086 Trainer kit
2. Exercises/Experiments using MASM (PC required)
3. Interfacing Exercises/Experiments with 8086 trainer kit through Assembly Language programming
4. Exercises/Experiments using 8051 trainer kit.

SYSTEM SOFTWARE LAB:

1. Experiments related to the operating system.
2. Exercises/Experiments related to the assemblers, loaders and macroprocessors.

TEXT BOOKS

1. Bhurchandi and Ray, Advanced Microprocessors and Peripherals, Third Edition McGraw Hill.
2. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2015.
3. Leland L. Beck, System Software: An Introduction to Systems Programming, 3/E, Pearson Education Asia, 1997.

REFERENCE MATERIALS

1. A. Nagoor Kani, Microprocessors and Microcontrollers, Second Edition, Tata McGraw Hill
2. Douglas V. Hall, SSSP Rao, Microprocessors and Interfacing, Third Edition, McGrawHill Education.
3. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
4. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education.
5. D.M. Dhamdhere, Systems Programming and Operating Systems, Second Revised Edition, Tata McGraw Hill.

MICROPROCESSORS LAB : List of Exercises/ Experiments

(Minimum 10 Exercises (at least 2 questions from each part I, II, III & IV)) : 2 Hrs/week

I. Assembly Language Programming Exercises/Experiments using 8086 Trainer kit

1. Implementation of simple decimal arithmetic and bit manipulation operations.

2. Implementation of code conversion between BCD, Binary, Hexadecimal and ASCII.

3. Implementation of searching and sorting of 16-bit numbers.

II. Exercises/Experiments using MASM (PC Required)

4. Study of Assembler and Debugging commands.

5. Implementation of decimal arithmetic (16 and 32 bit) operations.

6. Implementation of String manipulations.

7. Implementation of searching and sorting of 16-bit numbers.

III. Interfacing Exercises/Experiments with 8086 trainer kit through Assembly Language Programming

8. Interfacing with stepper motor - Rotate through any given sequence.

9. Interfacing with 8255 (mode0 and mode1 only).

10. Interfacing with 8279 (Rolling message, 2 key lockout and N-key rollover implementation).

11. Interfacing with Digital-to-Analog Converter.

IV. Exercises/Experiments using 8051 trainer kit

12. Familiarization of 8051 trainer kit by executing simple Assembly Language programs such as decimal arithmetic and bit manipulation.

13. Implementation of Timer programming (in mode1).

SYSTEM SOFTWARE LAB: List of Exercises/ Experiments

(Minimum 8 Exercises (All the 3 and at least 5 questions from each part V and VI)): 2 Hrs/week

V. Exercises/Experiments from operating system

1. Simulate the following file allocation strategies.

a) Sequential b) Indexed c) Linked

2. Implement the different paging techniques of memory management.

3. Simulate the following file organization techniques

a) Single level directory b) Two level directory c) Hierarchical

VI. Exercises/Experiments from assemblers, loaders and macroprocessor

1. Implement pass one of a two pass assembler.

2. Implement pass two of a two pass assembler.

3. Implement a single pass assembler.

4. Implement a two pass macro processor

5. Implement a single pass macro processor.

6. Implement an absolute loader.

7. Implement a relocating loader

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 15 marks
Continuous Evaluation in Lab	: 30 marks
Continuous Assessment Test	: 15 marks
Viva-voce	: 15 marks

CS1U38B	DATABASE MANAGEMENT SYSTEMS LAB	Category	L	T	P	Credits	Year of introduction
		PCC	0	0	4	2	2020

PRE-REQUISITE: CS1U20E Database Management Systems

COURSE OVERVIEW: The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches. **(Cognitive Knowledge Level: Apply)**
CO2	Construct queries using SQL for database creation, interaction, modification, and updation. **(Cognitive Knowledge Level: Apply)**
C03	Design and implement triggers and cursors. (Cognitive Knowledge Level: **Apply**)
C04	Implement procedures, functions, and control structures using PL/SQL**. (Cognitive Knowledge Level: Apply)**
CO5	Perform CRUD operations in NoSQL Databases. **(Cognitive Knowledge Level: Apply)**
C06	Develop database applications using front-end tools and back-end DBMS. **(Cognitive Knowledge Level: Create)**

SYLLABUS

1. Design a database schema for an application with ER diagram from a problem description**.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands **.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships** (with the ER diagram designed in step 1).
4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands) **.
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases) **.
6. Implementation of built-in functions in RDBMS**.
7. Implementation of various aggregate functions in SQL**.
8. Implementation of Order By, Group By & Having clause **.
9. Implementation of set operators nested queries, and join queries **.
10. Implementation of queries using temp tables.
11. Practice of SQL TCL commands like Rollback, Commit, Savepoint **.
12. Practice of SQL DCL commands for granting and revoking user privileges **.
13. Practice of SQL commands for creation of views and assertions ** .
14. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN- ELSIF, CASE, WHILE using PL/SQL **.
15. Creation of Procedures, Triggers and Functions**.
16. Creation of Packages **.
17. Creation of Cursors **.
18. Creation of PL/SQL blocks for exception handling **.
19. Database backup and restore using commands.
20. Query analysis using Query Plan/Show Plan.
21. Familiarization of NoSQL Databases and CRUD operations**.
22. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables**.

** mandatory

TEXT BOOKS

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 2013.
2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

REFERENCE MATERIALS

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 15 marks
Continuous Evaluation in Lab	: 30 marks
Continuous Assessment Test	: 15 marks
Viva-voce	: 15 marks

B.Tech (MINOR)

CS0M30A	CONCEPTS IN SOFTWARE ENGINEERING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE:CS1U20C Object Oriented Programming using Java.

COURSE OVERVIEW: This course provides fundamental knowledge in the Software Development Process. It covers Software Development, Quality Assurance and Project Management concepts. This course enables the learners to apply state of the art industry practices in Software development.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Differentiate Traditional and Agile Software Development approaches **(Cognitive Knowledge Level: Understand)**
CO2	Prepare Software Requirement **Specification** and Software Design for a given problem. **(Cognitive Knowledge Level: Apply**)
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project. **(Cognitive Knowledge Level: Apply**)
CO4	Make use of software project management concepts while planning, estimation, scheduling, tracking and change management of a project, with proper application of SCRUM, Kanban and Lean frameworks. (**Cognitive Knowledge Level: Apply**)
CO5	Utilize SQA practices, Process Improvement techniques and Technology improvements **namely** cloud based software model and containers & microservices in a Software Development Process. (**Cognitive Knowledge Level: Apply**)

SYLLABUS

Introduction to Software Engineering - Professional software development -Software engineering ethics. Software process models- Agile software development -Functional and non-functional requirements, Requirements engineering processes. Design concepts - Design within the context of software engineering. Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development -Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, Software Evolution - Evolution processes, Software maintenance -Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Configuration management, Version management, System building, Change management, Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software.

TEXT BOOKS

1. Ian Sommerville, Software Engineering, Pearson Education, Tenth edition, 2015.
2. Roger S. Pressman, Software Engineering : A practitioner's approach, McGraw Hill publication, Eighth edition, 2014
3. Ian Sommerville, Engineering Software Products: An Introduction to Modern Software Engineering, Pearson Education, First Edition, 2020.

REFERANCE MATERIALS

1. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications
2. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design— Software Design Descriptions
3. David J. Anderson, Kanban, Blue Hole Press 2010
4. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
5. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
6. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.
7. Satya Nadella, Hit Refresh: The Quest to Rediscover Microsoft's Soul and Imagine a Better Future for Everyone, Harper Business, 2017
8. Henrico Dolfing, Project Failure Case Studies: Lessons learned from other people's mistakes, Kindle edition
9. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
10. StarUML documentation - https://docs.staruml.io/
11. OpenProject documentation - https://docs.openproject.org/
12. BugZilla documentation - https://www.bugzilla.org/docs/
13. GitHub documentation - https://guides.github.com/
14. Jira documentation - https://www.atlassian.com/software/jira

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Software Engineering - Professional software development, Software engineering ethics. Software process models - The waterfall model, Incremental development. Process activities - Software specification, Software design and implementation, Software validation, Software evolution. Coping with change - Prototyping, Incremental delivery, Boehm's Spiral Model. Agile software development - Agile methods, agile manifesto -	12

	values and principles. Agile development techniques, Agile Project Management. Case studies : An insulin pump control system. Mentcare - a patient information system for mental health care.	
II	Functional and non-functional requirements, Requirements engineering processes. Requirements elicitation, Requirements validation, Requirements change, Traceability Matrix. Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts - Design within the context of software engineering, Design Process, Design concepts, Design Model. Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design - What is a component?, Designing Class-Based Components, Conducting Component level design, Component level design for web-apps. Template of a Design Document as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure.	**12**
III	Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. Review Techniques - Cost impact of Software Defects, Code review and statistical analysis. Informal Review, Formal Technical Reviews, Post-mortem evaluations. Software testing strategies - Unit Testing, Integration Testing, Validation testing, System testing, Debugging, White box testing, Path testing, Control Structure testing, Black box testing, Testing Documentation and Help facilities. Test automation, Test-driven development, Security testing. Overview of DevOps and Code Management - Code management, DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.	**14**
IV	Software Project Management - Risk management, Managing people, Teamwork. Project Planning, Software pricing, Plan-driven development, Project scheduling, Agile planning. Estimation techniques, COCOMO cost modeling. Configuration management, Version management, System building, Change management, Release management, Agile software management - SCRUM framework. Kanban methodology and lean approaches.	**12**
V	Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks, Software measurement and metrics. Software Process Improvement(SPI), SPI Process CMMI process improvement framework, ISO 9001:2000 for Software.	**10**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

(Each student shall identify a software development problem and prepare Requirements Specification, Design Document, Project Plan and Test case documents for the identified problem as the assignment.)

CS0M30B	CONCEPTS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE:CS0M20E Mathematics for Machine Learning

COURSE OVERVIEW: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning & the naive Bayes algorithm, support vector machines& kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

COURSE OUTCOMES

CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.**(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate supervised learning concepts (regression, linear classification). **(Cognitive Knowledge Level**: **Apply**)
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine **(Cognitive Knowledge Level: Apply**)
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (**Cognitive Knowledge Level**: **Apply**)
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (**Cognitive Knowledge Level: Apply**)

SYLLABUS

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation. Regression - solution using gradient descent algorithm. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3. NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM. Clustering -Hierarchical Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction, Multidimensional scaling, Linear Discriminant Analysis. Classification Performance measures, Case Study: Develop a classifier for face detection.

TEXT BOOKS

1. EthemAlpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J Zaki and Wagner Meria, Data Mining and Analysis: Fundamental Concept and Algorithms, Cambridge University Press, first South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

REFERENCE MATERIALS

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

COURSE PLAN

Module	Contents	No. of hoursF
I	Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.	10
II	Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.	10
III	NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm.SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin	13

	linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).	
IV	Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	**13**
V	Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC). Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.	**14**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS0M30C	**CLIENT SERVER SYSTEMS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2020**

PRE-REQUISITE: Nil

COURSE OVERVIEW: The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO 1	Identify the basics of client/server systems and the driving force behind the development of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 2	Outline the architecture and classifications of client/server systems**(Cognitive Knowledge Level: Understand)**
CO 3	Summarize the client/server network services for an application**(Cognitive Knowledge Level: Understand)**
CO 4	Identify management services and issues in network **(Cognitive Knowledge Level: Understand)**
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture **(Cognitive Knowledge Level: Understand)**

SYLLABUS

Introduction-Client/Server Classification-Client/Server Application Components-Client/ Server Systems Services and Support-Client/Server Technology and Databases

TEXT BOOKS

1. Patrick Smith &Steve Guengerich, Client / Server Computing, PHI
2. Subhash Chandra Yadav, Sanjay Kumar Singh, An Introduction to Client/Server Computing, New Age International Publishers.

REFERENCE MATERIALS

1. Jeffrey D.Schank, “N0ovell’s Guide to Client-Server Application & Architecture” Novell Press
2. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition, Third Edition
3. Dawna Travis Dewire, Client Server Computing- McGraw Hill
4. W.H Inman, Developing Client Server Applications, BPB

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to Client/Server computing - Basic Client/Server Computing Model, Server for Every Client- File Server, Print Server, Application Server, Mail Server, Directory Services Server, Web Server, Database Server, Transaction Servers. Client/Server-Fat or Thin, Stateless or Stateful, Servers and Mainframes, Client/Server Functions. Driving Forces behind Client/Server Computing- Business Perspective, Technology Perspective.	**12**
II	Client/Server Types-Single Client/Single Server, Multiple Clients/Single Server, Multiple Clients/Multiple Servers, Integration With Distributed Computing, Alternatives To Client/Server Systems. Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Principles behind Client/Server Systems. Client/Server Topologies. Existing Client/Server Architecture. Architecture for Business Information System.	**11**
III	Client- Services, Request for services, RPC, Windows services, Print services, Remote boot services, other remote services, Utility Services. Server- Detailed server functionality, Network operating system, Available platforms, Server operating system. Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and disadvantages of Client/Server computing, Applications of Client/Server.	**12**
IV	Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability.	**13**

	Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.	
V	Client/Server Technology and Databases **-** Storing Data, Database System Architectures. Client/Server In Respect Of Databases- Client/Server Databases, Client/Server Database Computing, Database Computing Vs. Mainframe, PC/File Server Computing. Client/Server Database Architecture - Process-Per-Client Architecture, Multi-Threaded Architecture, Hybrid Architecture. Database Middleware Component - Application Programming Interface, Database Translator, Network Translator.	**12**

MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Test1 (for theory, for 2 hrs) : 20 marks

Continuous Assessment Test2 (for Lab, Internal Examination, for 2 hrs) : 20 marks

B.Tech (HONOURS)

CS1H30A	**CRYPTOGRAPHIC ALGORITHMS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2020**

PRE-REQUISITE:CS1H20A-Number Theory

COURSE OVERVIEW:

The course on Cryptographic Algorithms aims at exploring various algorithms deployed in offering confidentiality, integrity, authentication and non-repudiation services. This course covers classical encryption techniques, symmetric and public key crypto-system, key exchange and management, and authentication functions. The concepts covered in this course enable the learners in effective use of cryptographic algorithms for real life applications.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Identify the security services provided for different types of security attacks. (**Cognitive Knowledge Level : Understand**)
CO2	Summarize the classical encryption techniques for information hiding. (**Cognitive Knowledge Level: Apply**)
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.(**Cognitive Knowledge Level: Apply**)
CO4	Interpret key management techniques for secure communication.(**Cognitive Knowledge Level: Understand)**
CO5	Summarize message authentication functions in a secure communication scenario.(**Cognitive Knowledge Level: Understand**)

SYLLABUS

Need for security, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques- Encrypting communication channels. Symmetric key cryptographic Algorithms, DES, Block cipher principles, Differential and Linear cryptanalysis, Block cipher modes of operation, IDEA, AES, Stream cipher, RC4. Principles of public key cryptosystems, RSA algorithm, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems. Key Distribution-Public key infrastructure. Authentication requirements, functions, Algorithms and Services.

TEXT BOOKS

1. William Stallings, Cryptography and Network Security Principles and Practice, Pearson Edu, 6e.
2. BruiceSchneier, Applied Cryptography Protocols, Algorithms and source code in C, Wiley,2e.

REFERENCE MATERIALS

1. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.
2. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.
3. DouglasR. Stinson, Cryptography Theory and Practice, 3e, Chapman& Hall/CRC, 2006.
4. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2011.

COURSE PLAN

Module	Contents	No. of hours
I	Need for security, Security approaches, Principles of security, Types of attacks, OSI Security Architecture, Classical encryption techniques - Substitution techniques, Transposition techniques. Stream cipher, Block cipher, Public key cryptosystems vs. Symmetric key cryptosystems, Encrypting communication channels.	12
II	Overview of symmetric key cryptography, Block cipher principles, Data Encryption Standard (DES), Differential and Linear cryptanalysis, Double DES, Triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Algorithm (AES),Block cipher modes of operation, Stream cipher, RC4.	13

III	Principles of public key cryptosystems, RSA algorithm, RSA illustration, Attacks, ElGamal cryptographic system, Knapsack algorithm, Diffie-Hellman key exchange algorithm, Elliptical curve cryptosystems.	**12**
IV	Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of public keys, Generating keys, transferring keys, Verifying keys, Updating keys, Storing keys, Backup keys, Compromised keys, Public key infrastructure.	**12**
V	Authentication requirements, Authentication functions, Message authentication codes (MAC), Hash functions, Security of Hash functions and MAC, Message Digest 5 (MD5), Secure Hash Algorithm (SHA)-512, Hash-based Message Authentication Code (HMAC), Cipher-based Message Authentication Code (CMAC), X.509 Authentication services.	**11**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1H30B	**NEURAL NETWORKS AND DEEP LEARNING**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2020**

PRE-REQUISITE: CS1H20B Computational Fundamentals of Machine Learning

COURSE OVERVIEW:

Neural networks is a biologically inspired programming paradigm which enables a computer to learn from observational data and deep learning is a powerful set of techniques for training neural networks. This course introduces the key concepts in neural networks, its architecture and learning paradigms, optimization techniques, basic concepts in deep learning, Convolutional Neural Networks and Recurrent Neural Networks. The students will be able to provide best solutions to real world problems in domains such as computer vision and natural language processing.

COURSE OUTCOMES:After the completion of the course the student will be able to

CO1	Demonstrate the basic concepts of machine learning models and performance measures. **(Cognitive Knowledge Level : Understand)**
CO2	Illustrate the basic concepts of neural networks and its practical issues**(Cognitive Knowledge Level : Apply)**
CO3	Outline the standard regularization and optimization techniques for deep neural networks (**Cognitive Knowledge Level : Understand)**
CO4	Build CNN and RNN models for different use cases. **(Cognitive Knowledge Level : Apply)**
CO5	Explain the concepts of modern RNNs like LSTM, GRU **(Cognitive Knowledge Level : Understand)**

SYLLABUS

Machine Learning basics - Learning algorithms, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures. Single layer perceptrons, Multi Layer Perceptrons (MLPs), Activation functions. Risk minimization, Loss function, backpropagation, Practical issues in neural network training - Computational Challenges. Applications of neural networks. Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques. Convolutional Neural Networks Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST. Recurrent neural networks, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

TEXT BOOKS

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

REFERENCE MATERIALS

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018.

COURSE PLAN

Module	Contents	No. of hours
I	Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve(ROC), Area Under Curve(AUC).	**10**
II	Introduction to neural networks -Single layer perceptrons, Multi LayerPerceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.	**10**
III	Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.	**14**
IV	Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST	**13**
V	Recurrent neural networks **–** Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep	**13**

	recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.	

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1H30C	PRINCIPLES OF MODEL CHECKING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE: Nil

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

CO1	Illustrate an application for model checking. **(Cognitive Knowledge Level: Understand)**
CO2	Describe finite-state modelling of hardware and software. **(Cognitive Knowledge Level: Understand)**
CO3	Identify the linear-time properties required to represent the requirements of a system. **(Cognitive Knowledge Level: Apply**)
CO4	Specify a given linear-time property in Linear Temporal Logic (LTL). (**Cognitive Knowledge Level: Apply**)
CO5	Perform LTL model checking with the tool SAL (Symbolic Analysis Laboratory). (**Cognitive Knowledge Level: Apply**)

SYLLABUS

System Verification – Hardware and Software Verification - Model Checking, Characteristics - Transition Systems – Direct Predecessors and Successors, Terminal State, Deterministic Transition System - Execution Fragment: Maximal and Initial - - Reachable States - Modeling Hardware and Software Systems - Linear-Time (LT) Properties - Deadlock, Behavior - Paths and State Graph, Path Fragment, Maximal and Initial Path Fragment, Traces - LT Properties, Satisfaction Relation, Trace Equivalence. Safety Properties and Invariants - Liveness Properties - Safety vs. Liveness Properties. Fairness: Unconditional, Weak and Strong Fairness, Strategies, Fairness and Safety. Regular Safety property: Verifying. Automata on Infinite Words - ω -Regular Languages and Properties, Nondeterministic and Deterministic Buchi Automata Generalised Buchi Automata, Nested Depth-First Search. Linear Temporal

Logic (LTL) - Syntax, Semantics, Equivalence, Weak Until, Release and Positive Normal Form, . Automata Based LTL Model Checking. Introduction to the tool Symbolic Analysis Laboratory (SAL). The Language - The expression language, The transition Language, The module language, SAL Contexts. SAL Examples - Mutual Exclusion.

TEXT BOOKS

1. Christel Baier and Joost-Pieter Katoen, Principles of Model Checking, The MIT Press. (Modules 1 - 4)
2. Leonardo de Moura, Sam Owre and N. Shankar, The SAL Language Manual, SRI International (http://sal.csl.sri.com/doc/language-report.pdf, Chapters 1, 3, 4, 5, 6, 7) (Module 5).

REFERENCE MATERIALS

1. SAL Examples (http://sal.csl.sri.com/examples.shtml) (Module 5)

COURSE PLAN

Module	Contents	No. of hours
I	System Verification– Hardware and Software Verification, Model Checking, Characteristics of Model Checking. Transition Systems – Transition System, Direct Predecessors and Successors, Terminal State, Deterministic Transition System. Executions - Execution Fragment, Maximal and Initial Execution Fragment, Execution, Reachable States. Modeling Hardware and Software Systems- Sequential Hardware Circuits, Data Dependent Systems.	12
II	Linear-Time (LT) Properties - Deadlock. Linear-Time Behavior - Paths and State Graph, Path Fragment, Maximal and Initial Path Fragment, Path. Traces - Trace and Trace Fragment, LT Properties - LT Property, Satisfaction Relation for LT Properties, Trace Equivalence and LT Properties. Safety Properties and Invariants - Invariants, Safety Properties, Trace Equivalence and Safety properties. Liveness Properties - Liveness Property, Safety vs. Liveness Properties. Fairness - Fairness, Unconditional, Weak and Strong Fairness, Fairness Strategies, Fairness	12

	and Safety. (Definition and examples only for all topics - no proof required).	
III	Regular Properties - Model Checking Regular Safety properties - Regular Safety property, Verifying Regular Safety Properties. Automata on Infinite Words - ω -Regular Languages and Properties, Nondeterministic Buchi Automata (NBA), Deterministic Buchi Automata (DBA), Generalised Buchi Automata (Definitions only). Model Checking ω -Regular Properties - Persistence Properties and Product, Nested Depth-First Search (Only algorithms required).	**12**
IV	Linear Temporal Logic (LTL) - Syntax, Semantics, Equivalence of LTL Formulae, Weak Until, Release and Positive Normal Form, Fairness, Safety and Liveness in LTL (Definitions only). Automata Based LTL Model Checking (Algorithms and examples only).	**12**
V	Introduction **-** Introduction to the tool Symbolic Analysis Laboratory (SAL). The Language of SAL - The expression language, The transition Language, The module language, SAL Contexts. SAL Examples - Mutual Exclusion, Peterson's Protocol, Synchronous Bus Arbiter, Bounded Bakery protocol, Bakery Protocol, Simpson's Protocol, Stack.	**12**

MARK DISTRIBUTION

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

SEMESTER VI

CS1U30F	COMPILER DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2020

PRE-REQUISITE:CS1U20AData Structures andCS1U30AFormal Languages & Automata Theory

COURSE OVERVIEW: The purpose of this course is to create awareness among students about the phases of a compiler and the techniques for designing a compiler. This course covers the fundamental concepts of different phases of compilation such as lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation. Students can apply this knowledge in design and development of compilers.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Explain the phases in compilation process(lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization and code generation) and model a lexical analyser **(Cognitive Knowledge Level: Apply)**
CO2	Model language syntax using Context Free Grammar and develop parse tree representation using leftmost and rightmost derivations (**Cognitive Knowledge Level: Apply)**
CO3	Compare different types of parsers(Bottom-up and Top-down) and construct parser for a given grammar **(Cognitive Knowledge Level: Apply)**
CO4	Build Syntax Directed Translation for a context free grammar, compare various storage allocation strategies and classify intermediate representations **(Cognitive Knowledge Level: Apply)**
CO5	Illustrate code optimization and code generation techniques in compilation **(Cognitive Knowledge Level: Apply)**

SYLLABUS

Analysis of the source program, Compiler writing tools. Bootstrapping, Lexical Analysis, Role of the Syntax Analyser, Top-Down Parsing - Recursive Descent parsing, Predictive Parsing, LL(1) Grammars, Bottom-Up Parsing-Shift Reduce parsing, Operator precedence parsing, LR Parsing, Syntax directed translation, Run-Time Environments, Intermediate Code Generation, Code Optimization, Code Generation.

TEXT BOOKS

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools, Addison Wesley, 2006.

REFERENCE MATERIALS

1. D.M.Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.
2. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.
3. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company,1984.

COURSE PLAN

Module	Contents	No. of hours
I	Analysis of the source program - Analysis and synthesis phases, Phases of a compiler. Compiler writing tools. Bootstrapping. Lexical Analysis - Role of Lexical Analyser, Input Buffering, Specification of Tokens, Recognition of Tokens.	12
II	Role of the Syntax Analyser – Syntax error handling. Review of Context Free Grammars - Derivation and Parse Trees, Eliminating Ambiguity. Basic parsing approaches - Eliminating left recursion, left factoring. Top-Down Parsing - Recursive Descent parsing, Predictive Parsing, LL(1) Grammars.	14

III	Handle Pruning. Shift Reduce parsing. Operator precedence parsing (Concept only). LR parsing - Constructing SLR, LALR and canonical LR parsing tables.	**10**
IV	Syntax directed translation - Syntax directed definitions, S-attributed definitions, L-attributed definitions, Bottom-up evaluation of S-attributed definitions. Run-Time Environments - Source Language issues, Storage organization, Storage-allocation strategies. Intermediate Code Generation - Intermediate languages, Graphical representations, Three-Address code, Quadruples, Triples.	**14**
V	Code Optimization - Principal sources of optimization, Machine dependent and machine independent optimizations, Local and global optimizations. Code generation - Issues in the design of a code generator, Target Language, A simple code generator.	**10**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

<table>
<tr><td rowspan="2">CS1U30G</td><td rowspan="2">COMPUTER GRAPHICS
AND IMAGE PROCESSING</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Year of Introduction</td></tr>
<tr><td>PCC</td><td>3</td><td>1</td><td>0</td><td>4</td><td>2020</td></tr>
</table>

PRE-REQUISITE: Nil

COURSE OVERVIEW: The purpose of this course is to make awareness about strong theoretical relationships between computer graphics and image processing. This course helps the learner to understand three- dimensional environment representation in a computer, transformation of 2D/3D objects, basic mathematical techniques and algorithms used to build useful applications, imaging, and image processing techniques. The study of computer graphics and image processing develops the ability to create image processing frameworks for different domains and develops algorithms for emerging display technologies.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Describe the working principles of graphics devices**(Cognitive Knowledge level: Understand)**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms(Cognitive Knowledge level: Apply)
CO3	Demonstrate geometric representations, transformations on 2D & 3D objects, clipping algorithms and projection algorithms(Cognitive Knowledge level: Apply)
CO4	Summarize visible surface detection methods(Cognitive Knowledge level: Understand)

CO5	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships(Cognitive Knowledge level: Apply)
CO6	Solve image enhancement and segmentation problems using spatial domain techniques(Cognitive Knowledge level: Apply)

SYLLABUS

Basics of Computer Graphics and its applications. Video Display devices. Line drawing algorithms. Circle drawing algorithms. Filled Area Primitives. Two dimensional transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations. Window to viewport transformation. Cohen Sutherland Line clipping algorithm. Sutherland Hodgeman Polygon clipping algorithm. Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Depth buffer algorithm, Scan line algorithm. Introduction to Image processing and applications. Fundamental steps in image processing. Components of image processing system. Coordinate conventions. Sampling and quantization. Spatial and Gray Level Resolution. Basic relationship between pixels– neighbourhood, adjacency, connectivity. Fundamentals of spatial domain-convolution operation. Basic gray level transformation functions. Histogram equalization. Basics of spatial filtering - Sharpening spatial filters. Fundamentals of Image Segmentation. Thresholding. Region based Approach - Region Growing, Region Splitting and Merging. Edge Detection - Edge Operators- Sobel and Prewitt.

TEXT BOOKS

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Pearson, 4e, 2017

REFERENCE MATERIALS

1. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001.
2. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill 2019.
3. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
4. M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, Thomson India Edition, 4e, 2017.

COURSE PLAN

Module	Contents	No. of hours
I	Basics of Computer Graphics and its applications. Video Display devices- Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems. Line drawing algorithms- DDA, Bresenham's algorithm. Circle drawing algorithms- Midpoint Circle generation algorithm, Bresenham's algorithm.	10
II	Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates. Basic 3D transformations.	10
III	Window to viewport transformation. Cohen Sutherland Line clipping algorithm. Sutherland Hodgeman Polygon clipping algorithm. Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Depth buffer algorithm, Scan line algorithm.	13
IV	Introduction to Image processing and applications. Image as 2D data. Image representation in Gray scale, Binary and Colour images. Fundamental steps in image processing. Components of image processing system. Coordinate conventions. Sampling and quantization. Spatial and Gray Level Resolution. Basic relationship between pixels– neighbourhood, adjacency, connectivity. Fundamentals of spatial domain-convolution operation.	13
V	Basic gray level transformation functions - Log transformations, Power-Law transformations, Contrast stretching. Histogram equalization. Basics of spatial filtering - Smoothing spatial filter- Linear and nonlinear filters, and Sharpening spatial filters-Gradient and Laplacian.	14

	Fundamentals of Image Segmentation. Thresholding - Basics of Intensity thresholding and Global Thresholding. Region based Approach - Region Growing, Region Splitting and Merging. Edge Detection - Edge Operators- Sobel and Prewitt.	

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1U30H	**ALGORITHM ANALYSIS AND DESIGN**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		PCC	**3**	**1**	**0**	**4**	**2020**

PRE-REQUISITE: ES0U10E Programming in C, CS1U20A Data Structures and MA0U20E Graph Theory.

COURSE OVERVIEW: The course introduces students to the design of computer algorithms, as well as analysis of algorithms. Algorithm design and analysis provide the theoretical backbone of computer science and are a must in the daily work of the successful programmer. The goal of this course is to provide a solid background in the design and analysis of the major classes of algorithms. At the end of the course students will be able to develop their own versions for a given computational task and to compare and contrast their performance.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations. **(Cognitive Level: Apply)**
CO2	Derive recurrence equations and solve it using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms. **(Cognitive Level: Apply)**
CO3	Illustrate Graph traversal algorithms & applications and Advanced Data structures like AVL trees and Disjoint set operations. **(Cognitive Level:Apply)**
CO4	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques (**Cognitive Level: Apply)**
CO5	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability **(Cognitive Level: Understand)**
CO6	Identify the suitable design strategy to solve a given problem. **(Cognitive Level: Analyze)**

SYLLABUS

Introduction to algorithm analysis, Advanced data structures and graph algorithms, Various algorithm design techniques, Introduction to Complexity Theory and Approximation Algorithms.

TEXT BOOKS

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, Prentice-Hall India (2001)
2. Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Orient Longman Universities Press (2008)
3. Sara Baase and Allen Van Gelder —Computer Algorithms, Introduction to Design and Analysis, 3rd Edition, Pearson Education (2009)

REFERENCE MATERIALS

1. Jon Kleinberg, Eva Tardos, " Algorithm Design", First Edition, Pearson(2005)
2. Robert Sedgewick, Kevin Wayne, "Algorithms", 4th Edition Pearson(2011)
3. Gilles Brassard, Paul Brately, " Fundamentals of Algorithmics", Pearson(1996)
4. Steven S Sjiena, " The Algorithm Design Manual", 2nd Edition, Springer(2008)

COURSE PLAN

Module	Contents	No. of hours
I	Characteristics of Algorithms, Criteria for Analysing Algorithms, Time and Space Complexity - Best, Worst and Average Case Complexities, Asymptotic Notations - Big-Oh (O), Big- Omega (Ω), Big-Theta (Θ), Little-oh (o) and Little-Omega (ω) and their properties. Classifying functions by their asymptotic growth rate, Time and Space Complexity Calculation of simple algorithms. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (Proof not required).	13

II	Self Balancing Tree - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected); Disjoint Sets- Disjoint set operations, Union and find algorithms. DFS and BFS traversals - Analysis, Strongly Connected Components of a Directed graph, Topological Sorting.	12
III	The Control Abstraction of Divide and Conquer- 2-way Merge sort, Strassen's Algorithm for Matrix Multiplication-Analysis. The Control Abstraction of Greedy Strategy-Fractional Knapsack Problem, Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-Analysis.	12
IV	The Control Abstraction- The Optimality Principle- Matrix Chain Multiplication-Analysis, All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm-Analysis. The Control Abstraction of Back Tracking – The N Queen's Problem. Branch and Bound Algorithm for Travelling Salesman Problem.	11
V	Tractable and Intractable Problems, Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Coloring. Randomized Algorithms (Definitions of Monte Carlo and Las Vegas algorithms), Randomized version of Quick Sort algorithm with analysis.	12

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

HS0U30A	INDUSTRIAL ECONOMICS & FOREIGN TRADE	Category	L	T	P	Credit	Year of Introduction
		HSC	3	0	0	3	2020

PRE REQUISITE : NIL

COURSE OVERVIEW:

The course enables students to make better economic decisions in wage employment and entrepreneurship using economic alternatives and investment alternatives.

COURSE OUTCOMES

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

Course Outcomes	Description	Learning Level
CO 1	Explain the problem of scarcity of resources, consumer behaviour and the equilibrium condition of demand and supply.	Understand
CO 2	Demonstrate the production function and equilibrium condition of a producer	Understand
CO 3	Survey the functional requirement of a firm under various competitive conditions.	Analyse
CO 4	Infer the overall performance of the economy, the regulation of economic fluctuations and its impact on various sections in the society.	Analyse
CO 5	Compare the profitability of projects and businesses with the help of capital budgeting methods	Evaluate
CO 6	Determine the current impact of global economic policies on the business opportunities of a firm	Analyse

SYLLABUS

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency

Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation- causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers

REFERENCE MATERIALS

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications 2015
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications 2012
3. Dwivedi D.N., 'Macro Economics', Tata McGraw Hill, New Delhi
4. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai
5. Tulsian, 'Financial Management' S Chand & Company 2017
6. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi

COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	**8**
II	Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.	**8**
III	Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming. Principles of taxation - Direct Tax – Indirect Tax – GST. Concepts of demonetization. Cryptocurrency	**9**
IV	Circular flow of economic activities – Stock and flow Gross. National Income – Concepts - Methods of measuring national income – Inflation- causes and effects – Measures to control inflation. Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY. Capital Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio	**11**
V	Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers	**9**
	Total hours	**45**

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

<table>
<tr><td rowspan="2">CS1U30I</td><td rowspan="2">COMPREHENSIVE COURSE WORK</td><td>CATEGORY</td><td>L</td><td>T</td><td>P</td><td>CREDIT</td><td>YEAR OF INTRODUCTION</td></tr>
<tr><td>PCC</td><td>1</td><td>0</td><td>0</td><td>1</td><td>2020</td></tr>
</table>

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental core courses in the curriculum. Five core courses credited from semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course helps the learner to become competent in cracking GATE, placement tests and other competitive examinations

Prerequisite:

1. **Data Structures**
2. **Operating Systems**
3. **Computer Organization And Architecture**
4. **Database Management Systems**
5. **Formal Languages And Automata Theory**

Course Outcomes: After the completion of the course the student will be able to

CO1 :	Comprehend the concepts and applications of data structures (Cognitive Knowledge Level: **Understand)**
CO2 :	Comprehend the concepts, functions and algorithms in Operating System (Cognitive Knowledge Level: **Understand)**)
CO3 :	Comprehend the organization and architecture of computer systems (Cognitive Knowledge Level: **Understand)**
CO4 :	Comprehend the fundamental principles of database design and manipulation (Cognitive Knowledge Level: **Understand)**
CO5 :	Comprehend the concepts in formal languages and automata theory Cognitive Knowledge Level: **Understand)**

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyse	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice, a maximum of four options. Question paper includes fifty questions of one mark each, distributed equally from all the five identified courses.

Syllabus

Full Syllabus of all five selected Courses.

1. **Data Structures(CST201)**
2. **Operating Systems(CST206)**
3. **Computer Organization And Architecture(CST202)**
4. **Database Management Systems(CST204)**
5. **Formal Languages And Automata Theory(CST301)**

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**DATA STRUCTURES**	
1.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
1.2	Mock Test on Module 4 and Module 5	1 hour
1.3	Feedback and Remedial class	
2	**OPERATING SYSTEMS**	
2.1	Mock Test on Module 1 and Module 2	1 hour
2.2	Mock Test on Module 3, Module 4 and Module 5	1 hour
2.3	Feedback and Remedial class	1 hour
3	**COMPUTER ORGANIZATION AND ARCHITECTURE**	
3.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
3.2	Mock Test on Module 4 and Module 5	1 hour
4	**DATABASE MANAGEMENT SYSTEMS**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
4.2	Mock Test on Module 4 and Module 5	1 hour

4.3	Feedback and Remedial class	
5	**FORMAL LANGUAGES AND AUTOMATA THEORY**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1 hour
5.2	Mock Test on Module 4 and Module 5	1 hour
5.3	Feedback and Remedial class	1 hour

CS1U38C	NETWORKING LAB	CATEGORY	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2020

PRE-REQUISITE:ES0U10E-Programming in C, CS1U20A- Data Structures and CS1U30B-Computer Networks

COURSE OVERVIEW: The course enables the learners to get hands-on experience in network programming using Linux System calls and network monitoring tools. It covers implementation of network protocols and algorithms, configuration of network services and familiarization of network simulators. This helps the learners to develop, implement protocols and evaluate its performance for real world networks.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Use network related commands and configuration files in Linux Operating System. **(Cognitive Knowledge Level: Understand).**
CO2	Develop network application programs and protocols. **(Cognitive Knowledge Level: Apply)**
CO3	Analyze network traffic using network monitoring tools. **(Cognitive Knowledge Level: Apply)**
CO4	Design and setup a network and configure different network protocols. **(Cognitive Knowledge Level: Apply)**
CO5	Develop simulation of fundamental network concepts using a network simulator. **(Cognitive Knowledge Level: Apply)**

SYLLABUS

*****Mandatory

(Note: At least one program from each topic in the syllabus should be completed in the Lab)

1. Getting started with the basics of network configuration files and networking commands in Linux.*

2. To familiarize and understand the use and functioning of system calls used for network programming in Linux.*

3. Implement client-server communication using socket programming and TCP as transport layer protocol*

4. Implement client-server communication using socket programming and UDP as transport layer protocol*

5. Simulate sliding window flow control protocols.* (Stop and Wait, Go back N, Selective Repeat ARQ protocols)

6. Implement and simulate algorithm for Distance Vector Routing protocol or Link State Routing protocol.*

7. Implement Simple Mail Transfer Protocol.

8. Implement File Transfer Protocol.*

9. Implement congestion control using a leaky bucket algorithm.*

10. Understanding the Wireshark tool.*

11. Design and configure a network with multiple subnets with wired and wireless LANs using required network devices. Configure commonly used services in the network.*

12. Study of NS2 simulator*

REFERENCE MATERIALS

1. W. Richard Stevens, Bill Fenner, Andy Rudoff, UNIX Network Programming: Volume 1, The Sockets Networking API, 3rd Edition, Pearson, 2015
2. Lisa Bock, Learn Wireshark: Confidently navigate the Wireshark interface and solve real-world networking problems, Packt Publishing, 2019
3. TeerawatIssariyakul, Ekram Hossain, Introduction to Network Simulator NS2,2nd Edition, Springer,2019

MARK DISTRIBUTION

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 15 marks
Continuous Evaluation in Lab	: 30 marks
Continuous Assessment Test	: 15 marks
Viva-voce	: 15 marks

CS1U 39A	MINI PROJECT	Category	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2020

PRE-REQUISITE: A sound knowledge in any programming language and fundamental concepts of Software Engineering.

COURSE OVERVIEW:

The objective of this course is to apply the fundamental concepts of Software Engineering principles for the effective development of an application/research project. This course helps the learners to practice the different steps to be followed in the software development process such as literature review and problem identification, preparation of Software Requirement Specification &Software Design Document (SDD), testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Identify technically and economically feasible problems **(Cognitive Knowledge Level: Apply)**
CO2	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes **(Cognitive Knowledge Level: Apply)**
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques (**Cognitive Knowledge Level: Apply)**
CO4	Prepare technical report and deliver presentation **(Cognitive Knowledge Level: Apply)**
CO5	Apply engineering and management principles to achieve the goal of the project **(Cognitive Knowledge Level: Apply)**

Guidelines

Student Groups with 3 or 4 members should identify a topic of interest in consultation with a Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives by strictly following steps specified in the teaching plan. Innovative design concepts, performance, scalability, reliability considerations, aesthetics/ergonomic, user experience and security aspects taken care of in the project shall be given due weight. The progress of the mini project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department comprising HoD or a senior faculty member, Mini Project coordinator and project guide. The internal evaluation shall be made based on the progress/outcome of the project, reports and a viva-voce examination, conducted internally by a 3-member committee. A project report is required at the end of the semester. The project has to be demonstrated for its full design specifications.

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	75	75	

CONTINOUS ASSESSMENT EVALUATION PATTERN

Attendance	10 marks
Project Guide	15 marks
Project Report	10 marks

PROGRAM ELECTIVE I

CS1U31A	FOUNDATIONS OF MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2020

PRE-REQUISITE : Nil

COURSE OVERVIEW: This course enables the learners to understand the mathematical foundations of Machine Learning concepts. This course covers Linear Algebra, Probability and Distributions. Concepts in this course help the learners to identify the inherent assumptions & limitations of the current methodologies and develop new Machine Learning solutions.

COURSE OUTCOMES:

CO 1	Illustrate operations and applications of linear equations, matrix algebra, vector spaces, eigen values & eigenvectors **(Cognitive Knowledge Level: Apply)**
CO 2	Illustrate the concepts of orthogonality & diagonalization. **(Cognitive Knowledge Level: Apply)**
CO 3	Solve computational problems using probability and random variables. **(Cognitive Knowledge Level: Apply)**
CO 4	Identify an appropriate probability distribution for a given discrete or continuous random variable and use its properties. (**Cognitive Knowledge Level: Apply)**
CO 5	Illustrate moment generating function, law of large numbers and central limit theorems (**Cognitive Knowledge Level: Apply)**

SYLLABUS

Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings. Norms. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions, Eigen decomposition and Diagonalization. Probability Space. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density). Functions of a Random Variable. Joint Distributions, Conditional Distributions, Functions of Jointly Distributed Random Variables. Expected Values, Expectations of Functions of Random Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation. Moment-Generating Function. Limit Theorems, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution, Sample Mean and the Sample Variance.

TEXT BOOKS

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (freely available at https://mml – book.github.io)
2. John A. Rice, Mathematical Statistics and Data Analysis,University of California, Berkeley, Third Edition, published by Cengage.

REFERENCE MATERIALS

1. Gilbert Strang, Linear Algebra and Its Applications, 4th Edition.
2. Axler, Sheldon, Linear Algebra Done Right, 2015 Springer.
3. Stephen Boyd and LievenVandenberghe, Introduction to Applied Linear Algebra, 2018 published by Cambridge University Press.

COURSE PLAN

Module	Contents	No. of hours
I	Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces- Linear Independence, Basis and Rank, Linear Mappings.	6
II	Norms - Inner Products, Lengths and Distances, Angles and Orthogonality. Orthonormal Basis, Orthogonal Complement, Orthogonal Projections. Matrix Decompositions - Eigenvalues and Eigenvectors, Eigen decomposition and Diagonalization.	9
III	Probability Space - Sample Spaces, Probability Measures, Computing Probabilities, Conditional Probability, Baye's Rule, Independence. Random Variables - Discrete Random Variables (Bernoulli Random Variables, Binomial Distribution, Geometric and Poisson Distribution, Continuous Random Variables (Exponential Density, Gamma Density, Normal Distribution, Beta Density)	10
IV	Functions of a Random Variable. Joint Distributions - Independent Random Variables, Conditional Distributions, Functions of Jointly Distributed Random Variables.	10

	Expected Values - Expected Value of a Random Variable, Expectations of Functions of Random Variables, Expectations of Linear Combinations of Random Variables, Variance and Standard Deviation, Covariance and Correlation, Conditional Expectation	
V	Moment-Generating Function. Limit Theorems(Proof not expected) - Law of Large Numbers, Convergence in Distribution and the Central Limit Theorem. Distributions derived from the Normal Distribution - Chi-square, t, and F Distributions, Sample Mean and the Sample Variance.	**10**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS1U31B	DATA ANALYTICS	Category	L	T	P	Credits	Year of Introduction
		PEC	2	1	0	3	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: This course helps the learner to understand the basic concepts of data analytics. This course covers mathematics for data analytics, predictive and descriptive analytics of data, Big data and its applications, techniques for managing big data and data analysis & visualization using R programming tool. It enables the learners to perform data analysis on a real world scenario using appropriate tools.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Illustrate the mathematical concepts for data analytics **(Cognitive Knowledge Level: Apply)**
CO2	Explain the basic concepts of data analytics **(Cognitive Knowledge Level: Understand)**
CO3	Illustrate various predictive and descriptive analytics algorithms (**Cognitive Knowledge Level: Apply)**
CO4	Describe the key concepts and applications of Big Data Analytics **(Cognitive Knowledge Level: Understand)**
CO5	Demonstrate the usage of Map Reduce paradigm for Big Data Analytics **(Cognitive Knowledge Level: Apply)**
CO6	Use R programming tool to perform data analysis and visualization **(Cognitive Knowledge Level: Apply)**

SYLLABUS

Descriptive statistics, Association of two variables, Ordinal and Continuous variable, Probability calculus, Inductive statistics, Interval estimation, Hypothesis Testing, t- test. Introduction to Data Analysis, Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview. Basics of data collection, sampling, preprocessing and dimensionality reduction. Supervised Learning. Unsupervised Learning. Association Rule Mining - Apriori algorithm. Big Data Overview, Example Applications.Big Data Analytics using Map Reduce and Apache Hadoop. Overview of modern data analytic tools.Data Analysis Using R, Graphical User Interfaces, Data Import and Export, Exploratory Data Analysis - Visualization Before Analysis, Statistical Methods for Evaluation.

TEXT BOOKS

1. Bart Baesens," Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends", John Wiley & Sons, 2013.
2. David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.
3. Jaiwei Han, MichelineKamber, "Data Mining Concepts and Techniques'', Elsevier, 2006.
4. Christian Heumann and Michael Schomaker, "Introduction to Statistics and DataAnalysis", Springer, 2016

REFERENCE MATERIALS

1. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics. Pearson, 2012.
2. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.

COURSE PLAN

Module	Contents	No. of hours
I	Descriptive statistics - Measures of central tendency and dispersion, Association of two variables - Discrete variables, Ordinal and Continuous variable, Probability calculus - probability distributions, Inductive statistics - Point estimation, Interval estimation, Hypothesis Testing - Basic definitions, t- test	**9**
II	Introduction to Data Analysis - Analytics, Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview.	**6**

	Basics of data collection, sampling, preprocessing and dimensionality reduction	
III	Supervised Learning - Classification, Naive Bayes, KNN, Linear Regression. Unsupervised Learning - Clustering, Hierarchical algorithms – Agglomerative algorithm, Partitional algorithms - K-Means. Association Rule Mining - Apriori algorithm	**10**
IV	Big Data Overview – State of the practice in analytics, Example Applications - Credit Risk Modeling, Business Process Analytics.Big Data Analytics using Map Reduce and Apache Hadoop, Developing and Executing a HadoopMapReduce Program.	**10**
V	Overview of modern data analytic tools.Data Analysis Using R - Introduction to R - R Graphical User Interfaces, Data Import and Export, Attribute and Data Types, Descriptive Statistics, Exploratory Data Analysis - Visualization Before Analysis, Dirty Data, Visualizing a Single Variable, Examining Multiple Variables, Data Exploration Versus Presentation, Statistical Methods for Evaluation	**10**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS1U31C	FOUNDATIONS OF SECURITY IN COMPUTING	Category	L	T	P	Credit	Year Of Introduction
		PEC	2	1	0	3	2020

PRE-REQUISITE:MA0U20B- Discrete Mathematical Structures, CS1U20F-Operating Systems and CS1U20E-Database Systems.

COURSE OVERVIEW: The purpose of this course is to create awareness among learners about the fundamentals of security and number theory. This course covers Integer & Modular Arithmetic, Primes & Congruences, Discrete Logarithms & Elliptic Curve Arithmetic and an overview of computer security. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and to identify the security threats in computing.

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

CO1	Illustrate the operations and properties of algebraic structures, integer arithmetic and modular arithmetic. **(Cognitive Knowledge Level: Understand)**
CO2	Use the concepts of prime numbers and factorization for ensuring security in computing systems **(Cognitive Knowledge Level: Apply)**
CO3	Illustrate the concepts of Linear Congruence, Primitive Roots, Discrete Logarithms and Elliptic Curve Arithmetic **(Cognitive Knowledge Level: Apply)**
CO4	Summarize the threats and attacks related to computer and program security **(Cognitive Knowledge Level: Understand)**
CO5	Outline the key aspects of operating system and database security **(Cognitive Knowledge Level: Understand)**

SYLLABUS

Integer arithmetic-Modular arithmetic-Algebraic structures-Prime numbers-Fermat's theorem-Primality testing-Euler's theorem- Factorization-Linear congruence-Simultaneous linear congruence-Solving congruence modulo prime powers-Primitive roots-Elliptic curve arithmetic-Prime curves, Binary curves-Introduction to computer security-Browser attack types-Web attacks -Email attack types-Introduction to program security-Operating system security -Database security.

TEXT BOOKS

1. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.
2. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
3. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007

REFERENCE MATERIALS

1. William Stallings, Cryptography and Network Security Principles and Practices, 4/e, Pearson Ed.

COURSE PLAN

Module	Contents	No. of hours
I	Integer arithmetic - Integer division, Divisibility, Greatest Common Divisor (GCD), Euclid's algorithm for GCD, Extended Euclid's algorithm, Linear Diophantine Equations. Modular arithmetic - Operations, Properties. Algebraic structures - Groups, Rings, Fields, Finite fields, GF(p), GF (2^n).	8
II	Prime numbers - Prime numbers and prime-power factorization, Fermat and Mersenne primes, Fermat's theorem, Applications, Euler's theorem, Euler's totient function, Applications. Primality testing – Deterministic algorithms and Probabilistic algorithms. Factorization - Fermat's factorization, Pollard p-1 method.	10
III	Linear congruence - Simultaneous linear congruence, Chinese Remainder Theorem (CRT). Congruence with a prime - Power modulus, Arithmetic modulo p, Pseudoprimes and Carmichael numbers, Solving congruence modulo prime powers. Primitive roots - Existence of primitive roots for primes, Discrete logarithms. Elliptic curve arithmetic – Prime curves, Binary curves, Addition of two points, Multiplication of a point by a constant.	10
IV	Introduction to computer security – Threats, Vulnerabilities, Controls. Browser attack types, Web attacks targeting users, Email attack types. Introduction to program security - Non-malicious programming oversights, Malware.	9
V	Operating system security – Security in operating system, Security in design of operating system. Database security – Security	8

	requirements of databases, Reliability and integrity, Database disclosure.	

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1U31D	AUTOMATED VERIFICATION	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PEC	2	1	0	3	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW : This course is intended to impart the basic theory and algorithm for an automatic verification process namely model checking. This course covers finite-state modelling of hardware/software, linear-time properties, classification of linear-time properties, Linear Temporal Logic (LTL) - a formal language for property specification, LTL model checking algorithm and model checking case studies. This course enables the learners to prove correctness of a hardware/software used in safety critical systems in domains such as avionics, health care and automotive.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Illustrate an application for model checking. **(Cognitive Knowledge Level: Understand)**
CO2	Describe finite-state modelling for hardware and software. **(Cognitive Knowledge Level: Understand)**
CO3	Identify linear-time properties required to represent the requirements of a system. **(Cognitive Knowledge Level: Apply)**
CO4	Specify a given linear-time property in Linear Temporal Logic (LTL). **(Cognitive Knowledge Level: Apply)**
CO5	Perform LTL model checking using the tool Symbolic Analysis Laboratory (SAL). **(Cognitive Knowledge Level: Apply)**

SYLLABUS

System Verification, Transition Systems - Direct Predecessors and Successors, Executions, Linear-Time (LT) Properties - Deadlock - Maximal and Initial Path Fragment. Regular Properties - Automata on Infinite Words - ω-Regular Languages and Properties, Nondeterministic Buchi Automata (NBA), Deterministic Buchi Automata (DBA), Generalised Buchi Automata, Linear Temporal Logic (LTL) - Automata Based LTL Model Checking.

TEXT BOOKS

1. Christel Baier and Joost-Pieter Katoen, Principles of Model Checking, The MIT Press. (Modules 1 - 4)
2. Leonardo de Moura, Sam Owre and N. Shankar, The SAL Language Manual, SRI International (http://sal.csl.sri.com/doc/language-report.pdf, Chapters 1, 3, 4, 5, 6, 7) (Module 5)

REFERENCE MATERIALS

1. SAL Examples (http://sal.csl.sri.com/examples.shtml) (Module 5)

COURSE PLAN

Module	Contents	No. of hours
I	System Verification – Hardware and Software Verification, Model Checking, Characteristics of Model Checking. Transition Systems – Transition System, Direct Predecessors and Successors, Terminal State, Deterministic Transition System. Executions - Execution Fragment, Maximal and Initial Execution Fragment, Execution, Reachable States.	**8**
II	Linear-Time (LT) Properties - Deadlock. Linear-Time Behavior - Paths and State Graph, Path Fragment, Maximal and Initial Path Fragment, Path. Traces - Trace and Trace Fragment, LT Properties - LT Property, Satisfaction Relation for LT Properties, Trace Equivalence and LT Properties. Safety Properties and Invariants - Invariants, Safety Properties, Trace Equivalence and Safety properties. Liveness Properties - Liveness Property, Safety vs. Liveness Properties. Fairness - Fairness, Unconditional, Weak and Strong Fairness, Fairness Strategies, Fairness and Safety. (Definition and examples only for all topics - no proof required).	**10**
III	Regular Properties - Model Checking Regular Safety properties - Regular Safety property, Verifying Regular Safety Properties. Automata on Infinite Words - ω -Regular Languages and Properties, Nondeterministic Buchi Automata (NBA), Deterministic Buchi Automata (DBA), Generalised Buchi Automata (Definitions only). Model Checking ω -Regular Properties - Persistence Properties and Product, Nested Depth-First Search (Only algorithms required).	**11**
IV	Linear Temporal Logic (LTL) - Syntax, Semantics, Equivalence of LTL Formulae, Weak Until, Release and Positive Normal Form, Fairness,	**8**

	Safety and Liveness in LTL (Definitions only). Automata Based LTL Model Checking (Algorithms and examples only).	
V	Introduction - Introduction to the tool Symbolic Analysis Laboratory (SAL). The Language of SAL - The expression language, The transition Language, The module language, SAL Contexts. SAL Examples - Mutual Exclusion, Peterson's Protocol, Synchronous Bus Arbiter, Bounded Bakery protocol, Bakery Protocol, Traffic Signalling System.	**8**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks (Out of 15, 10 marks shall be given for a model checking projects to be implemented in SAL).

CS1U31E	PROGRAMMING IN PYTHON	Category	L	T	P	Credit	Year of Introduction
		PEC	2	1	0	3	2020

PRE-REQUISITE:NIL

COURSE OVERVIEW: The objective of the course is to equip the learners to develop multi-module software solutions for real world computational problems using Python. It encompasses the Python programming environment, syntax, data representations, intermediate level features, GUI programming, Object Oriented Programming and data processing. This course lays the foundation to develop modular software solutions including complex interactive applications, network applications, and data-driven intelligent applications.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Write, test and debug Python programs **(Cognitive Knowledge level: Apply)**
CO2	Illustrate uses of conditional (if, if-else and if-else-if) and iterative (while and for) statements in Python programs. **(Cognitive Knowledge level: Apply)**
CO3	Develop programs by utilizing the Python programming constructs such as Lists, Tuples, Sets and Dictionaries. **(Cognitive Knowledge level: Apply)**
CO4	Develop graphical user interface for solutions using Python libraries. (**Cognitive Knowledge level: Apply)**
CO5	Implement Object Oriented programs with exception handling. **(Cognitive Knowledge level: Apply)**
CO6	Write programs in Python to process data stored in files by utilizing Numpy, Matplotlib, and Pandas. **(Cognitive Knowledge level: Apply)**

SYLLABUS

Getting started with Python, Interactive shell, IDLE, iPython Notebooks, The software development process, Numeric data types and character sets, Expressions, Using inbuilt functions and modules. Control statements, Strings and text files,Design with Functions, Lists, Dictionaries. Case Study – Data Structure Selection. Graphics, Image Processing, Graphical User Interfaces, Design with classes, Exceptions, The os and sys modules, NumPy - Basics, Matplotlib, Working with CSV files. Introduction to Micro services using Flask.

TEXT BOOKS

1. Kenneth A Lambert., Fundamentals of Python : First Programs, 2/e, Cengage Publishing, 2016
2. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
3. Flask: Building Python web services, Jack Stouffer, Shalabh Aggarwal, Gareth Dwyer, PACKT Publishing Limited, 2018

REFERENCE MATERIALS

1. Zed A Shaw, Learn Python 3 The Hard Way, Addison-Wesley, 2017
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
4. Charles Severance. Python for Informatics: Exploring Information, CreateSpace Independent Publishing Platform, 2013.

COURSE PLAN

Module	Contents	No. of hours
I	Getting started with Python programming – Interactive shell, IDLE, iPython Notebooks, Detecting and correcting syntax errors, How Python works. The software development process – A case study. Basic coding skills – strings, assignment, and comments, Numeric data types and character sets, Expressions, Using inbuilt functions and modules. Control statements – Iteration with for/while loop, Formatting text for output, A case study, Selection structure (if-else, switch- case), Conditional iteration with while, A case study, Testing control statements, Lazy evaluation.	8
II	Strings and text files – Accessing characters, substrings, Data encryption, Strings and number system, String methods, Text files, A case study on text analysis. Design with Functions – Functions as Abstraction Mechanisms, Problem solving with top-down design,	9

	Design with recursive functions, Managing a program's namespace, Higher-Order Functions. Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times, A case study with lists. Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries, reverse lookup. Case Study – Data Structure Selection.	
III	Graphics – Terminal-based programs, Simple Graphics using Turtle, Operations, 2D Shapes, Colors and RGB Systems, A case study. Image Processing – Basic image processing with inbuilt functions. Graphical User Interfaces – Event-driven programming, Coding simple GUI-based programs : Windows, Labels, Displaying images, Input text entry, Popup dialog boxes, Command buttons, A case study.	**9**
IV	Design with classes - Objects and Classes, Methods, Instance variables, Constructor, Accessor and Mutator, Data-Modeling Examples, Structuring classes with inheritance and polymorphism. Abstract classes, Interfaces, Exceptions - Handle a single exception, handle multiple exceptions.	**9**
V	The os and sys modules, NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Plotting and visualization. Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files. – Pandas - Reading, Manipulating, and Processing Data. Introduction to Micro services using Flask.	**10**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1U31F	ADVANCED DATA COMMUNICATION	Category	L	T	P	Credits	Year of Introduction
		PEC	2	1	0	3	2020

PRE-REQUISITE: NIL

COURSE OVERVIEW: The purpose of this course is to prepare learners to understand the communication entities and the associated issues in data transmission. This course covers fundamental concepts of data transmission in digital and analog form, transmission media, concepts of encoding, multiplexing, spread spectrum and switching methods. This course helps the learner to gain insight into the important aspects of data communication and computer networking systems and enables to apply in practical applications.

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

CO	Course Outcomes
CO1	Identify the characteristics of signals for analog and digital transmissions (**Cognitive knowledge: Apply**)
CO2	Identify the issues in data transmission (**Cognitive knowledge: Apply**)
CO3	Choose appropriate signal encoding techniques for a given scenario (**Cognitive knowledge: Apply**)
CO4	Illustrate multiplexing and spread spectrum technologies (**Cognitive knowledge: Apply**)
CO5	Use error detection, correction and switching techniques in data communication (**Cognitive knowledge: Apply**)
CO6	Identify the characteristics of Mobile Networks (**Cognitive knowledge: Apply**)

SYLLABUS

Periodic analog signals, Transmission impairments, Data rate limits, Nyquist bandwidth, Noisy channel, Shannon's capacity formula. Digital data to a digital signal, Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to analog signal- ASK, FSK, PSK. Analog data to analog signal- AM, FM, PM. Multiplexing, Spread spectrum techniques, Digital data communication techniques, Detecting and correcting errors, Basic principles of switching - Circuit switching, Packet switching, message switching. Mobile Communications, Introduction to GSM- Services, GPRS – Architecture, UMTS – Architecture.

TEXT BOOKS

1. Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.
2. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

REFERENCE MATERIALS

1. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

COURSE PLAN

Module	Contents	No. of hours
I	Periodic analog signals- Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.	9
II	Digital data to digital signal – Non-Return-to-Zero (NRZ), Return-to-Zero (RZ), Multilevel binary, Biphase. Analog data to digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to analog signal - Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK). Analog data to analog signal - Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM).	9
III	Multiplexing - Frequency Division Multiplexing (FDM), Wavelength Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread spectrum techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	9

IV	Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming distance, Hamming code. Basic principles of switching - Circuit switching, Packet switching, Message switching.	**9**
V	Mobile Communications: Generation of mobile communication Technologies, Introduction to GSM- Services & Architecture, Protocols, Connection Establishment, Routing, GPRS – Architecture, UMTS – Architecture, Handover.	**9**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

B.TECH(MINOR)

CS0M30D	INTRODUCTION TO SOFTWARE TESTING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE: Nil

COURSE OVERVIEW: This is a course in theoretical computer science that includes test cases for white-box, black- box, and grey-box approaches. This course describes the various techniques for test case design used to test software artifacts, including requirements, design, and code. The course includes different techniques for test case design based on graphs, programming language syntaxes and inputs. The course also covers symbolic execution using the PEX tool.

COURSE OUTCOMES: After the completion of the course the student will be able to:-

CO1	List a range of different software testing techniques and be able to apply specific unit testing methods to the projects using Junit**. (Cognitive Knowledge Level: Understand)**
CO2	Explain mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods. **(Cognitive Knowledge Level: Understand)**
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program. **(Cognitive Knowledge Level: Understand**)
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing. **(Cognitive Knowledge Level: Understand)**
CO5	Illustrate the use of PEX tool with symbolic execution. **(Cognitive Knowledge Level: Apply)**

SYLLABUS

Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing-. Testing Methods - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse. Overview of Graph Coverage Criteria. Data Flow Criteria

- du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Class inheritance testing: Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.

TEXT BOOKS

1. Paul Ammann and JeffOffutt , Introduction to Software Testing.
2. KshirasagarNaik and PriyadarshiTripathy, Software Testing And Quality Assurance: Theory And Practice.

REFERENCE MATERIALS

1. https://www.csc.ncsu.edu/academics/undergrad/honors/thesis/muclipsebinder.pdf- Muclipse tutorial.
2. King, James C, “Symbolic Execution and Program Testing”, Association for Computing Machinery, July 1976.

COURSE PLAN

Module	Contents	No. of hours
I	Some Popular Errors – Ariane 5, Therac 25, Intel Pentium Bug. What is Software testing? Why should it be tested? Software Quality, Role of Testing. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Testing Methods - Black Box testing, White Box testing, Grey Box testing.	12
II	Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Case Study - Mutation testing using Junit and Muclipse.	10

III	Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage. Data Flow Criteria - du paths, du pairs. Subsumption Relationships among Graph Coverage Criteria. Graph Coverage for Source Code - Control flow graphs for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics. Graph Coverage for Design Elements - Call graphs and classes, Class inheritance testing: Coverage criteria, Coverage criteria on inheritance graph, Data flow at the design level, Inter-procedural DU pairs, Coupling du-pairs example. Example - Quadratic Root. Case Study - Graph Based testing using JUnit Framework.	**14**
IV	Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage. TriTyp example. Functional Testing - Functional Testing Concepts of Howden. Functional testing - Important Steps. Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing. Case Study - Black Box testing approaches using JUnit.	**12**
V	Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing. An Introduction to PEX - Parameterized Unit Testing, The Testing Problem. Symbolic Execution – Example, Symbolic execution tree. PEX application Case Study – PEX.	**12**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS0M30E	CONCEPTS IN DEEP LEARNING	Category	L	T	P	Credits	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE:MA0U10A LINEAR ALGEBRA AND CALCULUS

COURSE OVERVIEW: This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Deep learning is a subfield of machine learning, a subfield of artificial intelligence. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered here. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

COURSE OUTCOMES:

CO1	Demonstrate basic concepts in machine learning.**(Cognitive Knowledge Level: Understand)**
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets. **(Cognitive Knowledge Level: Understand)**
CO3	Demonstrate the concept of the feed forward neural network and its training process. **(Cognitive Knowledge Level: Apply)**
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases. **(Cognitive Knowledge Level: Apply)**
CO5	Use different neural network/deep learning models for practical applications. **(Cognitive Knowledge Level: Apply)**

SYLLABUS

INTRODUCTION TO DEEP LEARNING, Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Overfitting, underfitting, hyper parameter tuning. Neural Networks. Gradient Descent solution for Perceptron, Multilayer perceptron. Introduction to optimization linear least squares. Stochastic gradient descent, Building ML algorithms and challenges. Convolutional Neural Networks. Practical challenges of common deep learning architectures. Case study-pretrained models. Recurrent neural networks, recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Applications – computer vision, speech recognition, natural language processing. Research Areas – auto encoders, representation learning, boltzmann machines, deep belief networks.

TEXT BOOKS

1. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018

REFERENCE MATERIALS

1. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks by Russell Reed, Robert J MarksII, A Bradford Book,2014
2. Practical Convolutional Neural Networks by MohitSewak, Md.Rezaul Karim, Pradeep Pujari, Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by Sudharsan Ravichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet, Manning Publications Co.,2018.

COURSE PLAN

Module	Contents	No. of hours
	INTRODUCTION TO DEEP LEARNING (General Instructions: Instructors are to introduce students to any one software platform and demonstrate the working of the algorithms in the syllabus using suitable use cases and public	

	datasets to give a better understanding of the concepts discussed. Tutorial hour may be used for this purpose)	
I	Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	**10**
II	Neural Networks **–**Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization**–** Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.	**10**
III	Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet	**13**
IV	Recurrent neural networks **–** Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.	**13**
V	Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks	**14**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

CS0M30F	WIRELESS NETWORKS AND IoT APPLICATIONS	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE:CS0M20C- Data Communication, CS1U30B- Computer Networks and ES0U10E-Programming in C

COURSE OVERVIEW: This course equips the learners with fundamental wireless technologies for the Internet of Things(IoT) and the IoT ecosystem. It covers the underlying concepts in wireless networks, communication mechanisms, protocols, hardware, software, and the cloud platforms for IoT. The students will be able to design smart IoT applications for real world problems.

COURSE OUTCOMES: After the completion of the course the students will be able to

CO1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO6	Build IoT-based smart real-time applications such as Smart Healthcare, Smart Agriculture, Smart Environment and Smart Home **(Cognitive Knowledge Level : Apply)**

SYLLABUS

Internet of Things-Role of Things and the Internet-Wireless IoT-Network Topologies, Types of Networks-Role of Wireless Standards in IoT-Protocols for Wireless IoT-Internet of Things - IoT Architectural View-IoT Application Areas-Design Principles for Web Connectivity-Internet Connectivity Principles-IP addressing in the IoT-Data Acquiring And Storage for IoT Services-Big data Acquiring Methods-Cloud Computing for Data storage-Sensor Technologies for IoT Devices-Sensor Data Communication Protocols-Embedded Computing Basics, Embedded Hardware Unit-

Programming using Arduino-Business Models and Processes using IoT-Business Models and Processes using IoT.

TEXT BOOKS

1. Daniel Chew, "Wireless Internet of Things -A Guide to the lower layers", IEEE Standards and Association, IEEE Press, Wiley
2. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited.

REFERENCE MATERIALS

1. ArshadeepBahga, Vijay Madisetti, "Internet of Things: A hands-on approach", University Press, 2015 (First edition)
2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
3. Dr.OvidiuVermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013
4. Simon Monk, "Programming Arduino: Getting Started with Sketches", McGraw Hill Publications.

COURSE PLAN

Module	Contents	No. of hours
I	Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT. Protocol Stack - OSI Model, TCP/IP Model, IEEE 802 Reference Model, Protocols for Wireless IoT. Bluetooth - Transceiver, Frequency Channels, Typical Range, Access and Spread Spectrum, Modulation and Data Rate, Error Correction and Detection, Network Topology. ITU G.9959, Zwave, IEEE 802.15.4, Zigbee Specification, Thread, WiFi, 6LowPAN, IPv6, LoRaWAN.	10
II	Internet of Things - IoT Architectural View, Technology Behind IoT - Server End Technology, Sources of Internet of Things, M2M Communication. IoT Application Areas. IoT Examples. IoT Data Management - Device Management Gateways. Design Principles for Web Connectivity - Web Communication Protocols for Connected	8

	Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	
III	Data Acquiring and Storage for IoT Services- Organization of Data, Big data, Acquiring Methods, Management Techniques, Analytics, Storage Technologies. Cloud Computing for Data storage - IoT Cloud based Services using Xively, Nimbits, and Other Platforms. Sensor Technologies for IoT Devices - Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuators for Various Devices, Sensor Data Communication Protocols, Wireless Sensor network Technology	**9**
IV	Embedded Computing Basics, Embedded Hardware Unit. Embedded Platforms for Prototyping - Arduino, Intel Galileo, Intel Edison, Raspberry Pi, BeagleBone, mBed. Prototyping and Designing the Software for IoT Applications- Introduction, Prototyping Embedded DeviceSoftware- Programming using Arduino, Programming for an Arduino Controlled Traffic Control Lights at a Road Junction, Basic Arduino Programs to Blink LED, Find the Distance using Ultrasonic Sensor, Estimate Room Temperature, Measuring Soil Moisture Level	**10**
V	Business Models and Processes using IoT. Value Creation in the Internet of Things. Cloud PaaS- Xively, Nimbits, IBM Bluemix, CISCO IoT, AWS IoT, TCS Connected AWS Platform, Case studies- Smart Home, Smart Environment, Smart healthcare, Smart agriculture.	**8**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests	: 25 marks
Continuous Assessment Assignment	: 15 marks

B.TECH(HONOURS)

CS1H30D	**NETWORK SECURITY**	**Category**	**L**	**T**	**P**	**Credits**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2020**

PRE-REQUISITE: CS1H20A- Number Theory and

CS1H30A- Cryptographic Algorithms.

COURSE OVERVIEW: The purpose of this course is to create a better understanding of the network security concepts. This course covers network security standards, email security services, web security mechanisms, firewalls and wireless security mechanisms. This course helps the learner to gain insight into the key aspects of secure network communication and enables to apply in real-life scenarios.

COURSE OUTCOMES: After the completion of the course the student will be able to

CO1	Identify the key aspects of security, intrusion detection systems and digital signature schemes **(Cognitive Knowledge Level: Apply)**
CO2	Explain the security standards used in network communication **(Cognitive Knowledge Level: Understand)**
CO3	Identify the mechanisms in email security services **(Cognitive Knowledge Level: Apply)**
CO4	Summarize the protocols used to provide web security **(Cognitive Knowledge Level: Understand)**
CO5	Explain the fundamental concepts of wireless network security and firewalls **(Cognitive Knowledge Level: Understand)**

SYLLABUS

Introduction to network security-Malicious programs-Digital signatures-Kerberos v4-Cryptographic algorithms-Public Key Infrastructure (PKI)-Real-time communication security-Denial-of-Service protection-Internet Protocol Security (IPSec)-Internet Key Exchange (IKE) phases-Introduction to email security-Privacy Enhanced Mail (PEM)-Introduction to web security-IEEE 802.11 Wireless LAN -Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA)-Firewalls .

TEXT BOOKS

1. C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", 2/e, PHI.
2. William Stallings, "Cryptography and Network Security Principles and Practice", 5/e, Pearson Education Asia.

REFERENCE MATERIALS

1. Behrouz A. Forouzan, DebdeepMukhopadhyay, "Cryptography and Network Security", 3/e, Tata McGraw Hill.
2. Tyler Wrightson, "Wireless Network Security A Beginner's Guide", 2012, Tata McGraw Hill.
3. William Stallings, "Network Security Essentials: Applications and Standards", 4/e, Prentice Hall.
4. Schiller J., Mobile Communications, 2/e, Pearson Education.
5. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to network security - Security requirements, Challenges of security, Network security model. Malicious programs – Worms, Viruses, Trojans, Spyware, Adware. Intrusion Detection Systems (IDS) - Uses, Techniques. Digital signatures - ElGamal, Schnorr, Digital Signature Standard (DSS).	8
II	Kerberos v4 – Configuration, Authentication, Encryption, Message formats. Kerberos v5 – Cryptographic algorithms, Message formats. Public Key Infrastructure (PKI) – Trust models, Revocation. Real-time communication security – Perfect Forward Secrecy (PFS), Denial-of-Service protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security	10

	(IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.	
III	Introduction to email security - Security services for email, Establishing keys, Privacy, Authentication, Message integrity, Non-repudiation. Privacy Enhanced Mail (PEM) – Encryption, Source authentication and integrity protection, Message formats. Secure/Multipurpose Internet Mail Extensions (S/MIME) – Messages, Differences from PEM. Pretty Good Privacy (PGP) - Encoding, Certificate and key revocation, Anomalies, Object formats.	**10**
IV	Introduction to web security - Web security considerations, Threats. Secure Sockets Layer (SSL) – Architecture, Protocols, Transport Layer Security (TLS) – Differences from SSL. Hypertext Transfer Protocol Secure (HTTPS) – Connection initiation, Closure. Secure Shell (SSH) – Transport layer protocol, User authentication protocol, Connection protocol	**8**
V	IEEE 802.11 Wireless LAN - Network components, Architectural model, Services. IEEE 802.11i wireless LAN security - Services, Phases of operation. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2, Wireless Application Protocol (WAP) – Services, Protocol architecture. Firewalls – Need for firewalls, Packet filters, Circuit-level firewalls, Application layer firewalls.	**9**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1H 30E	ADVANCED TOPICS IN MACHINE LEARNING	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE : Nil

COURSE OVERVIEW: This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the naive Bayes algorithm, basic clustering algorithms, auto encoders, sampling methods and PAC learning. This course helps the students to provide machine learning based solutions to real world problems.

COURSE OUTCOMES:

CO1	Illustrate the concepts of regression and classification techniques **(Cognitive Knowledge Level: Apply)**
CO2	Demonstrate various unsupervised learning techniques **(Cognitive Knowledge Level: Apply)**
CO3	Choose suitable model parameters for different machine learning techniques and to evaluate a model performance **(Cognitive Knowledge Level: Apply)**
CO4	Explain the framework of PAC learning, basic concepts of VC dimension and non-uniform learnability **(Cognitive Knowledge Level: Understand)**
CO5	Construct Bayesian models for data and apply computational techniques to draw inferences **(Cognitive Knowledge Level: Apply)**
CO6	Illustrate the concepts of sampling algorithms, auto encoder, generative adversarial networks **(Cognitive Knowledge Level: Apply)**

SYLLABUS

Overview of machine learning - supervised, semi-supervised, unsupervised learning, reinforcement learning Regression algorithms: least squares linear regression, gradient descent, closed form, normal equations, regularization techniques (LASSO, RIDGE), polynomial regression. Discriminative Methods - Logistic Regression, Decision Tree Learning. Generative Methods - Naive Bayes Classifier, Gaussian Discriminant Analysis (GDA). Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, K-medoids clustering, Gaussian mixture models. Classification Performance measures. Ensemble Methods. Sample complexity, computational complexity of training, Sample complexity for finite hypothesis spaces, PAC results for learning conjunctions, Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis(VC) dimension. Graphical models, Markov random fields(MRFs), Inference on chains and factor graphs, inference on clique trees. Monte Carlo methods, Markov chain Monte Carlo(MCMC), Gibbs sampling. Variational methods. Auto Encoder, Variational Auto Encoder, Generative Adversarial Networks.

TEXT BOOKS

1. Christopher M. Bishop. Pattern recognition and machine learning. Springer 2006.
2. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
3. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
4. Ian Good fellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016.
5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar. Foundations of Machine Learning. Second edition. MIT Press 2018.
6. Tom Mitchell. Machine Learning. McGraw Hill 1997.
7. Richard O. Duda, Peter E . Hart, David G. Stork. Pattern classification, Second Edition. Wiley.
8. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining Concepts and Techniques, Third Edition. Morgan Kaufmann.
9. David Foster. Generative Deep Learning - Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, Inc., June 2019.

REFERENCE MATERIALS

1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
2. Carl Edward Rasmussen and Christopher K. I. Williams. Gaussian Processes for Machine Learning. MIT Press 2005.

COURSE PLAN

Module	Contents	No. of hours
I	Overview of machine learning - supervised, semi-supervised, unsupervised learning, reinforcement learning Regression algorithms: least squares linear regression, gradient descent, closed form, normal equations, regularization techniques (LASSO, RIDGE), polynomial regression. Discriminative Methods - Logistic Regression, Decision Tree Learning. Generative Methods - Naive Bayes Classifier, Gaussian Discriminant Analysis (GDA).	**10**
II	Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, K-medoids clustering, Gaussian mixture models: Expectation Maximization (EM) algorithm for Gaussian mixture model.	**10**
III	Classification Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC, generalisation and overfitting, cross-validation, bias-variance tradeoff, error estimation, parameter and model selection. Ensemble Methods - Bagging, Boosting, Adaboost, Random Forests	**13**
IV	Models of learnability- learning in the limit, probably approximately correct (PAC) learning. Sample complexity- quantifying the number of examples needed to PAC learn, Computational complexity of training, Sample complexity for finite hypothesis spaces, PAC results for learning conjunctions, Sample complexity for infinite hypothesis spaces, Vapnik-Chervonenkis.0(VC) dimension.	**13**
V	Graphical models - Bayesian belief networks, Markov random fields(MRFs), Inference on chains and factor graphs, inference on clique trees. Monte Carlo methods – Basic sampling algorithms, rejection sampling, importance sampling, Markov chain Monte Carlo(MCMC), Gibbs sampling. Variational methods. Auto Encoder, Variational Auto Encoder, Generative Adversarial Networks	**14**

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

CS1H30F	THEORY OF COMPUTABILITY AND COMPLEXITY	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2020

PRE-REQUISITE: CS1U20A Data Structures and CS1U30A Formal Languages and Automata Theory.

COURSE OVERVIEW: This is a theoretical course in computer science to enable the learners to know the fundamentals of computability and complexity theories. It covers the notions of computability/decidability, the process of reduction to prove decidability/undecidability and the classification of problems into class P, class NP and class NP Complete based on the time complexity of solving the problems. This course helps the learner to identify whether a real life problem is decidable/undecidable and also to classify a decidable problem into tractable or intractable, based on the time complexity class it belongs.

COURSE OUTCOMES:

CO1	Illustrate relative computing powers of Finite State Automata, Push Down Automata, Linear Bounded Automata and Turing Machines.**(Cognitive Knowledge Level: Apply)**
CO2	Prove that a given language is undecidable/not semi-decidable by using the reduction process.**(Cognitive Knowledge Level: Apply)**
CO3	Describe the time complexity of a given problem as a function of the number of steps required by a Turing machine to solve it. **(Cognitive Knowledge Level: Understand)**
CO4	Utilize polynomial time reduction to prove that a given problem is NP Complete. **(Cognitive Knowledge Level: Apply)**

SYLLABUS

Introduction to formal language theory, Undecidability, Overview of complexity classes, NP completeness and NP complete problems.

TEXT BOOKS

1. Dexter C. Kozen, Automata and Computability, Springer (1999)
2. Michael Sipser, Introduction to the Theory of Computation, Second Edition

REFERENCE MATERIALS

1. Douglas B. West, Introduction to Graph Theory, Second Edition

COURSE PLAN

Module	Contents	No. of hours
I	Finite State Automata, Push Down Automata, Linear Bounded Automata, Turing Machines, Recursive Languages, Recursively Enumerable Languages, Universal Turing Machine, Enumeration Machine, Two Counter Machine.	14
II	Halting Problem, Language representation of a problem, Reduction - applications, Rice's First and Second Theorem with proof.	14
III	Measuring time complexity, Asymptotic notations - Big O and small-o, Analysing algorithms, Complexity relationship among models. Complexity classes- Class P, example problems in class P, Class NP, Polynomial time verification, example problems in class NP.	12
IV	Satisfiability problem, Polynomial time reducibility, Overview of Graphs, NP Complete Problems, Cook-Levin theorem (SAT is NP Complete).	10
V	CLIQUE, Vertex Cover and Hamiltonian path with proof of correctness of NP Completeness	10

MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

CONTINOUS INTERNAL EVALUATION PATTERN

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

SEMESTER VII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U40A	ARTIFICIAL INTELLIGENCE	PCC	2	1	0	3	2020

i. PRE-REQUISITE : Nil

ii. COURSE OVERVIEW

The course aims to introduce the fundamental principles of intelligent systems to students. This involves ideas about the characteristics of intelligent systems, knowledge representation schemes, logic and inference mechanisms. The course helps the learner to understand the design of self-learning systems along with some of their typical applications in the emerging scenario where the business world is being transformed by the progress made in machine learning.

iii. COURSE OUTCOMES

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

CO1	Explain the fundamental concepts of intelligent systems and their architecture.	Understand
CO2	Illustrate uninformed and informed search techniques for problem solving in intelligent systems.	Understand
CO3	Solve Constraint Satisfaction Problems using search techniques.	Apply
CO4	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems.	Apply
CO5	Illustrate different types of learning techniques used in intelligent systems	Understand

iv. SYLLABUS

Introduction: Artificial Intelligence(AI),Problem Solving: Solving Problems by searching-Problem solving Agents, Knowledge Representation and Reasoning. Logical Agents: Knowledge based agents, Logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic. First Order Predicate Logic – Syntax and Semantics of First Order Logic, Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution. Search in Complex environments: Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems, Backtracking search for CSPs, Structure of CSP problems. Machine Learning :Learning from Examples – Forms of Learning, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

v. (a) TEXT BOOKS

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition.

Prentice Hall.
2. Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.
3. Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.
4. Denis Rothman. Artificial Intelligence by Example, Packt, 2018

(b) OTHER REFERENCES

1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd.

vi. COURSE PLAN

Module	Contents	No. of hours
I	Introduction, What is Artificial Intelligence(AI)?, The foundations of AI, The history of AI, Applications of AI, Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, The nature of Environments, The structure of Agents	7
II	Solving Problems by searching-Problem solving Agents, Illustration of the problem solving process by agents, Searching for solutions, Uninformed search strategies: BFS, Uniform-cost search, DFS, Depth-limited search, Iterative deepening depth-first search, Informed search strategies: Best First search, Informed search strategies: A* Search, Heuristic functions.	10
III	Logical Agents – Knowledge based agents and logic, Propositional Logic, Propositional Theorem proving, Agents based on Propositional Logic, First Order Predicate Logic – Syntax and Semantics of First Order Logic, Using First Order Logic, Knowledge representation in First Order Logic, Inference in First Order Logic – Propositional Vs First Order inference, Unification and Lifting, Forward chaining, Backward chaining, Resolution	10
IV	Adversarial search – Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Constraint Propagation-inference in CSPs, Backtracking search for CSPs, The structure of problems.	9
V	Learning from Examples – Forms of Learning, Supervised Learning, Learning Decision Trees, Generalization and overfitting, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.	9
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U40A	INDUSTRIAL SAFETY ENGINEERING	MNC	2	1	0	-	2020

i) **PRE-REQUISITE:** NIL

ii) **COURSE OVERVIEW:**

Objective of the course to impart knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context.

iii) **COURSE OUTCOMES:**

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

CO No	Course Outcomes	Level
CO1	Explain the theories of accident causation and preventive measures of industrial accidents.	Understand
CO2	Explain about personal protective equipments, its selection, safety performance, role of housekeeping and work permits in industry.	Understand
CO3	Explain different safety issues in construction industries.	Understand
CO4	Summarize various hazards associated with different machines and material handling.	Understand
CO5	Explain different hazard identification tools in industries with the knowledge of different types of chemical hazards.	Understand

iv) **SYLLABUS:**

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management,

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning &

Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Ergonomics Hazards **-** Musculoskeletal Disorders and Cumulative Trauma Disorders**.**

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. Hearing Conservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, Material Safety Data Sheets

a) TEXTBOOKS

1) R.K Jain (2000) Industrial Safety, *Health and Environment management systems*, Khanna Publications.
2) Paul S V (2000), *Safety management System and Documentation training* Programme handbook, CBS Publication.
3) Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.

b) REFERENCES

1) AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Procedures*. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.
2) Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.

vi)

COURSE PLAN:

Module	**Contents**	**No. of hours**
I	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety, organization- objectives, types, functions, Role of management, supervisors, workers, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.	**9**

II	Personal protection in the work environment, Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces. Technology generation and development, technology generation, process, technology development, importance of technology generation and development.	**9**
III	Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	**9**
IV	Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	**9**
V	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets	**9**
	Total hours	**45**

vii) ASSESSMENT PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	**50**	**100**	**3 Hours**

Continuous Internal Evaluation Pattern:

Attendance	**10 Marks**
Continuous Assessment Tests (2 numbers)	**25 Marks**
Assignment/Quiz/Course project	**15 Marks**

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U48A	COMPILER DESIGN LAB	PCC	0	0	3	2	2020

i. PRE-REQUISITE : CS1U30F Compiler Design.

ii. COURSE OVERVIEW

This course aims to offer students hands-on experience on compiler design concepts. Students will be able to familiarize with tools such as LEX and YACC and automate different phases of a compiler. This course helps the learners to enhance the capability to design and implement a compiler.

iii. COURSE OUTCOMES

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

CO 1	Implement lexical analyzer using the tool LEX.	Apply
CO 2	Implement Syntax analyzer using the tool YACC.	Apply
CO 3	Design NFA and DFA for a problem and write programs to perform operations on it.	Apply
CO 4	Design and Implement Top-Down parsers.	Apply
CO 5	Design and Implement Bottom-Up parsers.	Apply
CO 6	Implement intermediate code for expressions.	Apply

iv. SYLLABUS

1. Implementation of lexical analyzer using the tool LEX.
2. Implementation of Syntax analyzer using the tool YACC.
3. Application problems using NFA and DFA.
4. Implement Top-Down Parser.
5. Implement Bottom-up parser.

6. Simulation of code optimization Techniques.
7. Implement Intermediate code generation for simple expressions.
8. Implement the back end of the compiler.

PRACTICE QUESTIONS

List of Exercises/Experiments:

1. Design and implement a lexical analyzer using C language to recognize all valid tokens in the input program. The lexical analyzer should ignore redundant spaces, tabs and newlines. It should also ignore comments.
2. Implement a Lexical Analyzer for a given program using Lex Tool.
3. Write a lex program to display the number of lines, words and characters in an input text.
4. Write a LEX Program to convert the substring *abc* to *ABC* from the given input string.
5. Write a lex program to find out total number of vowels and consonants from the given input sting.
6. Generate a YACC specification to recognize a valid arithmetic expression that uses operators +, –, *, / and parenthesis.
7. Generate a YACC specification to recognize a followed by any number of letters or digits.
8. Implementation of Calculator using LEX and YACC
9. Convert the BNF rules into YACC form and write code to generate abstract syntax tree.
10. Write a program to find ε – closure of all states of any given NFA with ε transition.
11. Write a program to convert NFA with ε transition to NFA without ε transition.
12. Write a program to convert NFA to DFA.
13. Write a program to minimize any given DFA.
14. Write a program to find First and Follow of any given grammar.
15. Design and implement a recursive descent parser for a given grammar.
16. Construct a Shift Reduce Parser for a given language.

17. Write a program to perform constant propagation.

18. Implement Intermediate code generation for simple expressions.

19. Implement the back end of the compiler which takes the three address code and produces the 8086 assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, jump etc

v. (a) TEXT BOOK

1. Aho A.V., Ravi Sethi and D. Ullman. Compilers – Principles Techniques and Tools,Addison Wesley, 2006.

(b) OTHER REFERENCES

1. D.M.Dhamdhere, System Programming and Operating Systems, Tata McGraw Hill & Company, 1996.

2. Kenneth C. Louden, Compiler Construction – Principles and Practice, Cengage Learning Indian Edition, 2006.

3. Tremblay and Sorenson, The Theory and Practice of Compiler Writing, Tata McGraw Hill & Company,1984.

vi. CONTINOUS ASSESSMENT EVALUATION PATTERN

(a)	Attendance	:	15 marks
(b)	Continuous Assessment	:	30 marks
(c)	Internal Test (Immediately before the II internal test)	:	30 marks
	Total	**:**	**75 marks**

vii. CONTINUOUS ASSESSMENT EXAMINATION PATTERN

- **One test of 30 marks** (complete syllabus)
- Duration – **2 ½ hours**

viii. END SEMESTER EXAMINATION PATTERN

(a)	Preliminary work	:	15 marks
(b)	Implementing the work/Conducting the experiment	:	20 marks
(c)	Performance, result and inference	:	15 marks
(d)	Viva voce	:	20 marks
(e)	Record	:	5 Marks
	Total	**:**	**75 marks**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U49A	SEMINAR	PWS	0	0	3	2	2020

i. PRE-REQUISITE : Nil

ii. COURSE OVERVIEW

The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

iii. COURSE OUTCOMES

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

CO1	Identify academic documents from the literature which are related to her/his areas of interest.	Apply
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest	Analyze
CO3	Prepare a presentation about an academic document	Create
CO4	Give a presentation about an academic document	Apply
CO5	Prepare a technical report.	Create

iv. GENERAL GUIDELINES

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based

rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the projectteam could choose or be assigned Seminar topics that covers various aspects linked to the Project area.

- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

iv. EVALUATION PATTERN

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based onher/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc).

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U49B	PROJECT PHASE I	PWS	0	0	6	2	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies

iii. COURSE OUTCOMES

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

CO1	Model and solve real world problems by applying knowledge across domains	Apply
CO2	Develop products, processes or technologies for sustainable and socially relevant applications	Apply
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks .	Apply
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms .	Apply
CO5	Identify technology/research gaps and propose innovative/creative solutions.	Analyze
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms .	Apply

iv. PHASE 1 TARGET

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

v. EVALUATION GUIDELINES & RUBRICS

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic The originally selected topic lack substance and needs to be revised. There were suggestion given to improve the relevance and quality of the project topic Only a few relevant reference were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity; however, some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real-world problem and is potentially innovative. The group show extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 -3 Marks)	(4 -6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build o plan on what materials resources to use in the project The students do not have any idea on the budget required The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials /resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide Each member knows well about their individual tasks.
			(0-3 Marks)	(4 -6 Marks)	(7 - 9 Marks)	(10 Marks)
Phase 1 Interim Evaluation Total Marks: 20						

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well-defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 -1 Marks)	(2 -3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities and is a passive member.	The student shows some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well	The student takes a leadership position and supports the other team member and leads the project Shows clear evidence of leadership.
			(0 -3 Marks)	(4 -6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design n/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are no prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount Of preliminary investigation and design/ analysis modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.

	[CO1]		(0 -3 Marks)	(4 -6 Marks)	(7 - 9 Marks)	(10 Marks)
1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done but not extensive. Interaction with the guide is minimal. Presentation includes some points of interest, but overall quality needs to be improved Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well planned and can easily grow into the project report. The presentation is done professionally and with great clarity The performance is excellent.
			(0 -1 Marks)	(2 -3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

PROGRAM ELECTIVE II

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41A	MACHINE LEARNING	PEC	2	1	0	3	2020

i. PRE-REQUISITE : Nil

ii. COURSE OVERVIEW

This course enables the learners to understand the advanced concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning and the Naive Bayes algorithm, basic clustering algorithms and classifier performance measures. This course helps the students to provide machine learning based solutions to real world problems.

iii. COURSE OUTCOMES

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

CO1	Illustrate Machine Learning concepts and basic parameter estimation methods.	Apply
CO2	Demonstrate supervised learning concepts (regression, Linear classification).	Apply
CO3	Illustrate the concepts of Multilayer neural network and Support Vector Machine	Apply
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques.	Apply
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures .	Apply

iv. SYLLABUS

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation, Introduction to Bayesian formulation. Supervised Learning: Regression Linear Methods for Classification- Logistic regression, Naive Bayes, Decision tree algorithm ID3. Neural Networks (NN) and Support Vector Machines (SVM): Perceptron, Neural Network - SVM, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF). Unsupervised Learning: Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction –Principal Component Analysis

Classification Assessment: Classification Performance measures, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.

v. COURSE PLAN

Module	Contents	No. of Hours
I	Supervised, semi-supervised, unsupervised learning, reinforcement learning, Maximum likelihood estimation(MLE), Maximum likelihood estimation (MLE)-example, Maximum a posteriori estimation(MAP), Maximum a posteriori estimation(MAP)-example, Bayesian formulation, Bayesian formulation -example	8
II	Linear regression with one variable, Multiple variables, Solution using gradient descent algorithm and matrix method (No derivation required),	9

	Overfitting in regression, Lasso and Ridge regularization, Logistic regression, Naive Bayes, Decision trees, Decision trees- ID3 algorithm.	
III	Perceptron, Perceptron Learning, Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU,Tanh), Back Propagation Algorithm, Illustrative Example for Back Propagation, Introduction, Maximum Margin Hyperplane, Mathematics behind Maximum Margin Classification, Formulation of maximum margin hyperplane and solution, Soft margin SVM, Solution of Soft margin SVM, Non-linear SVM , Kernels for learning non-linear functions, Examples -Linear, RBF, Polynomial.	11
IV	Similarity measures- Minkowski distance measures(Manhattan, Euclidean), Cosine Similarity, Clustering - Hierarchical Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering, Expectation maximization (EM) for soft clustering, Dimensionality reduction – Principal Component Analysis, Dimensionality reduction – Principal Component Analysis.	9
V	Performance measures - Precision, Recall, Accuracy, F-Measure, ROC, AUC, Boot strapping, Cross validation, Ensemble methods- bagging, boosting, Bias-Variance decomposition, Bias-Variance decomposition, Face detection	8
	Total hours	**45**

vi. (a) TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

(b) OTHER REFERENCES

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
4. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
5. Richert and Coelho, Building Machine Learning Systems with Python.
6. Davy Cielen, Arno DB Meysman and Mohamed Ali.Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41B	CLOUD COMPUTING	PEC	2	1	0	3	2020

i. PREREQUISITE: CS1U20F Operating Systems, CS1U30B Computer Networks

ii. COURSE OVERVIEW:

This course helps the learners to understand cloud computing concepts. This course includes basic understanding of virtualization, fundamentals of cloud security, cloud computing based programming techniques and different industry popular cloud computing platforms. This course enables the student to suggest cloud based solutions to real world problems.

iii. COURSE OUTCOMES

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

CO1	Explain the various cloud computing models and services.:	Understand
CO2	Demonstrate the significance of implementing virtualization techniques.	Understand
CO3	Explain different cloud enabling technologies and compare private cloud platforms.	Understand
CO4	Apply appropriate cloud programming methods to solve big data problems. (Cognitive Knowledge Level.	Apply
CO5	Describe the need for security mechanisms in cloud .	Understand
CO6	Compare the different popular cloud computing platforms.	Understand

iv. SYLLABUS

Fundamentals of Cloud Computing, Overview of Computing Paradigms. NIST reference Model. Cloud deployment models. Introduction to Virtualization, Types of VMs- process, Hardware-level virtualization. Types of Hypervisors, VMware.

Cloud-Enabling Technologies, Private cloud platforms and programming. Resource provisioning techniques, Open-source software platforms for private, Cloud Programming, Map Reduce, Fundamental Cloud Security, Popular Cloud Platforms.

v. (a) TEXT BOOKS

1. Thomas, E., Zaigham M., Ricardo P "Cloud Computing Concepts, Technology & Architecture.", (2013 Edition). Prentice Hall.
2. Buyya, R., Vecchiola, C., & Selvi, S. T. “Mastering cloud computing: foundations and applications programming”, (2017 Edition), Morgan Kaufmann.
3. Bhowmik, S., “Cloud computing”, (2017 Edition). Cambridge University Press.

(b) OTHER REFERENCES

1. Marinescu, D. C., “Cloud computing: theory and practice.”, (2017 Edition). Morgan Kaufmann.
2. Buyya, R., Broberg, J., & Goscinski, A. M., “Cloud computing: Principles and paradigms” (2011 Edition). John Wiley & Sons.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Fundamental Cloud Computing** Traditional computing: Limitations, Overview of Computing Paradigms: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing, NIST reference Model, Basic terminology and concepts, Cloud characteristics and benefits, challenges. Roles and Boundaries, Cloud delivery (service) models: Infrastructure-as-a-Service (IaaS), Platform-asa-Service (PaaS), Software-as-a-Service (SaaS), XaaS (Anything-as-a-service), Cloud deployment models: Public cloud, Community cloud, Private cloud, Hybrid cloud	7
II	**Virtualization** Introduction to virtualization, Virtualizing physical computing resources Virtual Machines (Machine virtualization):- non-virtualized v/s virtualized machine environments, Types of VMs: process VM v/s system VM, Emulation, interpretation and binary translation, Hardware-level virtualization: Hypervisors/VMM, Types of Hypervisors, Full Virtualization, Para-Virtualization, Hardware-assisted virtualization, OS level virtualization, Basics of Network Virtualization, Storage Virtualization and Desktop Virtualization, Pros and cons of virtualization, Case Study: Xen: Para-virtualization, Case Study: VMware: full virtualization	10
III	**Cloud-Enabling Technologies, Private cloud platforms and programming** Broadband networks and internet architecture: Internet Service Providers (ISPs), Data center technology, Web technology, Multitenant technology, Service technology., Resource provisioning techniques: static and dynamic provisioning, Open-source software platforms for private cloud: OpenStack, Cloud Stack, Basics of Eucalyptus, Open-Nebula, Nimbus, Cloud Programming: Parallel Computing and Programming Paradigms, Map Reduce, Hadoop Library from Apache, HDFS, Pig Latin High Level Languages, Apache Spark	12
IV	**Fundamental Cloud Security** Basic terms and concepts in security, Threat agents, Cloud security threats/risks, Trust, Operating system security, Virtual machine security, Security of virtualization, Security Risks posed by Shared Images, Security Risks posed by Management OS, Infrastructure security: - Network Level Security, Host Level Security, Application level security, Security of the Physical Systems, Identity & Access Management, Access Control	9

V	**Popular Cloud Platforms** Amazon Web Services(AWS):- AWS ecosystem, Computing services: Amazon machine images, Elastic Compute Cloud (EC2), Advanced computing services, Storage services: Simple Storage System (Amazon S3), Elastic Block Store (Amazon EBS), Database Services, Amazon CDN Services and Communication services, Google Cloud Platform:- IaaS Offerings: Compute Engine (GCE), Cloud Storage, PaaS Offerings: Google App Engine (GAE), Storage services, Application services, Compute services, Database Services, SaaS Offerings: Gmail, Docs, Google Drive, Microsoft Azure: Azure Platform Architecture, Hyper-V, Azure Virtual Machine, Azure Compute services, Storage services	7
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41C	SECURITY IN COMPUTING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW:**

This course helps the learners to explore various algorithms to offer confidentiality, integrity, authentication &non-repudiation services and different attacks on system security with their countermeasures. It covers classical encryption techniques, symmetric and public key crypto- system, key distribution techniques, authentication functions, intruders, malicious software, and DDoS attacks. The concepts covered in this course enable the learners in effective use of cryptographic algorithms and appropriate countermeasures for securing real life applications.

iii. **COURSE OUTCOMES**

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

CO1	Identify the security services provided against different types of security attacks.:	Understand
CO2	Illustrate classical encryption techniques for information hiding.	Apply
CO3	Illustrate symmetric/asymmetric key cryptosystems for secure communication.	Apply
CO4	Explain message integrity and authentication methods in a secure communication scenario.	Understand
CO5	Interpret public/secret key distribution techniques for secure communication.	Understand
CO6	Identify the effects of intruders, malicious software and distributed denial of service attacks on system security.	Understand

iv. **SYLLABUS**

Basics of Security and Traditional Cryptosystems, Classical encryption techniques, Modern Symmetric Key Cryptosystems, Public Key Cryptosystems, Message Integrity and Authentication, Key Distribution and System Security, Distribution of public keys, Intrusion detection techniques, Password management. Malicious software.

v. **(a) TEXT BOOKS**

1. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Pearson Ed.
2. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.

(b) OTHER REFERENCES

1. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
2. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Basics of Security and Traditional Cryptosystems** OSI security architecture – Security attacks, Services, Mechanisms, Cryptography vs Cryptanalysis. Classical encryption techniques – Symmetric cipher model, Substitution ciphers – Monoalphabetic vs Polyalphabetic ciphers, Caesar cipher, Affine cipher, Playfair cipher, Vigenere cipher, Hill cipher, Transposition ciphers – Keyless, Keyed, Double transposition	8
II	**Modern Symmetric Key Cryptosystems** Symmetric key ciphers – Block vs Stream ciphers, Block cipher components, Product ciphers, Feistel and Non-Feistel ciphers, Data Encryption Standard (DES) – Structure, Key generation, Design criteria, Weaknesses, Double DES, Triple DES, Advanced Encryption Standard (AES) – Overall Structure, Stages of encryption/decryption, Key expansion, Block cipher modes of operation – Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC), Cipher Feedback Mode (CFB), Output Feedback Mode (OFB), Counter Mode (CTR), Stream ciphers – Structure, RC4	10
III	**Public Key Cryptosystems** Public key cryptosystems – Principles, Applications, Requirements, Conventional vs Public key cryptosystems, RSA Security, Attacks, ElGamal cryptosystem – Algorithm, Diffie-Hellman key exchange – Algorithm, Man-in- the-middle attack, Elliptic Curve Cryptography (ECC) – ElGamal ECC, Key exchange using ECC	9
IV	**Message Integrity and Authentication** Hash functions – Security requirements, Secure Hash Algorithm (SHA-512), Message Authentication Code (MAC) – Requirements, Uses, Hash-based MAC (HMAC), Cipher-based MAC (CMAC), Digital signatures – Attacks, Forgeries, Requirements, Direct Vs Arbitrated digital signatures, RSA digital signature, ElGamal digital signature, Digital Signature Standard (DSS)	9
V	**Key Distribution and System Security** Key management – Distribution of secret keys using symmetric and asymmetric encryption, Distribution of public keys, System security – Intruders, Intrusion detection techniques, Password management, Malicious software – Viruses, Related threats, Virus countermeasures, Distributed Denial of Service (DDoS) attacks – Types, Countermeasures	9
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks

Total Marks **: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41D	MODEL BASED SOFTWARE DEVELOPMENT	PEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW:

The objective of the course is to familiarize learners about the concepts and advantages of using model based software development. This course covers the methodologies in developing the model of a software, perform analysis on the model and automatic generation of code from the model. The OSATE framework and its plugins using the Architecture Analysis and Design Language(AADL) language is used in the course to demonstrate the end-to-end concept of MBSD which helps the learners to get a hands on experience.

iii. COURSE OUTCOMES

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

CO1	Explain the relevance of model based software development in the software development process.	Understand
CO2	Explain Model Driven Architecture with Computation Independent Model (CIM), Platform Independent Model(PIM), Platform Specific Model (PSM).	Apply
CO3	Illustrate software modeling with Architecture Analysis and Design Language (AADL).	Apply
CO4	Explain error annex using error modeling concepts and illustrate error modeling in AADL.	Understand
CO5	Illustrate the process of code generation from an AADL model.	Understand

iv. SYLLABUS

Introduction to Model Based Software Development: Software faults, Introduction to Model checking, Introduction to Automated Testing, Model Based Software Development (MBSD) MBSD based software development: Requirements, Analysis, Design and Implementation. Model-Driven Architecture - The modeling Levels-Computation Independent Model (CIM), Platform Independent Model (PIM), Platform Specific Model (PSM). Introduction to AADL, Comparison with UML. Modeling: Developing a Simple Model AADL: Components - Software, Hardware, Composite, Runtime semantics, Language syntax, AADL declarations, AADL classifiers, AADL system models and specifications Model Analysis: Safety Analysis - Fault tree analysis, Minimal cutsets. Error Modeling in AADL-Error Model Libraries and Subclause Annotations, Error Types and Common Type Ontology, Error Sources and Their Impact, Component Error Behavior, Compositional Abstraction of Error Behavior, Use of Properties in Architecture Fault Models, Error modeling example. Code Generation: Need for code generation, Categorization, Code Generation Techniques, Code Generation in AADL Model – Ocarina.

v. (a) TEXT BOOKS

1. Marco, Brambilla, Jordi Cabot, Manuel Wimmer, Model-Driven Software Engineering in Practice, 2/e, Synthesis Lectures on Software Engineering, 2017.

2. Christel Baier and Joost-Pieter Katoen, Principles of model checking, The MIT Press.
3. Thomas Stahl and Markus Volter, Model-Driven Software Development, Wiley, 2006.
4. David P. Gluch, Peter H. Feiler, Model-Based Engineering with AADL: An Introduction to the SAE Architecture Analysis & Design Language, Adison-Wesley, 2015.

(b) OTHER REFERENCES

1. Automated software testing : http://www2.latech.edu
2. Peter H. Feiler, David P. Gluch, John J. Hudak. The Architecture Analysis & Design Language(AADL): An Introduction.
3. de Niz, Dionisio, Diagrams and Languages for Model-Based Software Engineering of Embedded Systems: UML and AADL
4. FAA System Safety Handbook, Chapter 8: Safety Analysis/Hazard Analysis Tasks
5. Enno Ruijters, Marielle Stoelinga, Fault tree analysis: A survey of the state-of-the-art in modeling, analysis and tools.
6. Larson, Brian &Hatcliff, John & Fowler, Kim & Delange, Julien. (2013). Illustrating the AADL error modeling annex (v.2) using a simple safety-critical medical device. ACM SIGAda Ada Letters. 33. 65- 84. 10.1145/2527269.2527271.
7. Delange, Julien & Feiler, Peter &Hudak, John &Gluch, Dave. (2016). Architecture Fault Modeling and Analysis with the Error Model Annex, Version 2. 10.13140/RG.2.1.4224.7927

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction** Software faults, Introduction to Model Checking, Introduction to Automated Testing , Introduction to Automated Testing , Need for MBSD, MBSD Approach, Architecture centric model driven software development, AADL and architecture-centric model-based software systems	8
II	**Model Based Software Development** Model based software development process, Overview of MBSD methodology, Model Driven Architecture, MDA Definitions and Assumptions, The modeling levels, Introduction to AADL, Comparison of AADL with other modeling languages	9
III	**Modeling using AADL** Modeling in detail: AADL components, Modeling in detail: Developing a simple model, Modeling in detail: Define top level model with an example, AADL in detail: Explain AADL components, Language syntax, AADL declarations and classifiers, AADL system models and specifications, Case study: Power boat auto pilot system	9
IV	**Model Analysis** Introduction to safety analysis, Fault tree analysis, minimal cut sets, Error modeling with AADL - Error Model Libraries and Subclause Annotations, Error modeling with AADL - Error Types and Common Type Ontology, Error modeling with AADL - Error Sources and Their Impact, Component Error Behavior, Error modelling with AADL - Compositional Abstraction of Error Behavior, Use of Properties in Architecture Fault Models, Illustrate isolette error model	10

V	**Code Generation** Code generation and its advantages, Categorization, Code generation techniques - Templates + filtering, Template + metamodel, Frame processors, Code generation techniques - API-based generators, In-line generation, Code attributes, Code generation techniques - Code weaving Commonalities and Differences Between the Different Code generation Approaches, Code generation in AADL – Ocarina, Illustration of code generation using AADL model	9
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41E	WEB PROGRAMMING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** CS1U20C Object Oriented Programming Using Java and CS1U20E Database Management Systems

ii. **COURSE OVERVIEW**:

This course helps the learners to understand the web programming concepts. It includes the essential frontend and backend technologies needed for the development of web applications. The learners will have an opportunity to gain necessary web development skills such as HTML, CSS, JavaScript, PHP, MySQL integration, JSON and Laravel framework.

iii. **COURSE OUTCOMES**

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

CO1	Use Hyper Text Markup Language (HTML) for authoring web pages and understand the fundamentals of WWW.	Understand
CO2	Construct and visually format responsive, interactive web pages using CSS and JavaScript (JS) .	Apply
CO3	Construct websites using advanced sever side programming tool PHP.	Apply
CO4	Develop dynamic web applications using PHP and perform MySQL database operations.	Apply
CO5	Explain the importance of object exchange formats using JSON and the MVC based web application development frameworks (Laravel)	Understand

iv. **SYLLABUS**

Introduction to the Internet & WWW, Introduction to HTML5, Introduction to Stylesheets ,
Introduction to PHP Language Structure, Advanced PHP, Web Development Frameworks

v. **(a) TEXT BOOKS**

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, Internet & World Wide Web How to Program 5th Edition
2. Lindsay Bassett, Introduction to JavaScript Object Notation: A To-the-Point Guide to JSON 1st Edition, O'Reilly
3. Julie C. Meloni, Pearson -PHP, MySQL & JavaScript All in One, Sams Teach Yourself,5th Ed
4. Matt Stauffer," LARAVEL up and Running, A framework for building modern PHP apps"1st Edition, O'REILLY

(b) OTHER REFERENCES

1. Robert W Sebesta, Programming the World Wide Web, 7/e, Pearson Education Inc,8th Edition
2. Larry Ullman, Pearson- PHP 6 and MySQL 5 for Dynamic Web Sites: Visual QuickPro Guide

3. Eric van der Vlist, Danny Ayers, Erik Bruchez, Joe Fawcett, Alessandro Vernet",Wrox- Professional Web 2.0 Programming, Wiley-India edition
4. Web Technologies Black Book 2018(As per Mumbai University Syllabus) HTML, CSS3, JavaScript, iQuery, AJAX,PHP,XML,MVC and Laravel DT Editorial Services (ISBN: 9789386052490)

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction to Internet and WWW** Evolution of Internet &World Wide Web- Web Basics URI's & URL - MIME. **Introduction to HTML5** Structuring & editing an HTML5 document- Fundamentals of HTML, Headings-Images, Hyper Links, Internal Linking- Lists, Special Characters & Horizontal Rules- meta Elements- div and span, Tables- Forms,HTML5 Form input types, input and data list Elements and autocomplete attributes-Page Structure Elements, Multimedia-HTML5 Audio & video elements.	8
II	**Introduction to Cascading Style Sheets(CSS)** Introduction to CSS3-Basic syntax and structure-Inline Styles ,Embedded Style Sheets-Linking External Style Sheets, Exploring CSS Selectors-Properties-values, Positioning Elements: Absolute Positioning- Relative Positioning -Backgrounds-List Styles- TableLayouts, Box Model and Text Flow, Basics of Responsive CSS-Media port & Media Queries **Introduction to JavaScript** Introduction to Scripting- Programming fundamentals of JavaScript -Obtaining User Input with prompt Dialogs, Arithmetic-Decision Making Control Statements -Functions,Arrays - Objects,Document Object Model (DOM)- Form processing	10
III	**Introduction to PHP** Building blocks of PHP-Variables, Data Types simple PHP program , Converting between Data Types, Operators and Expressions -Flow Control functions , Control Statements -Working with Functions, Initialising and Manipulating Arrays- Objects,Working with Strings- String processing with Regular expression, Pattern Matching , Form processing and Business Logic.	9
IV	**PHP –MYSQL** Cookies- Sessions, PHP& MySQL Integration-Connecting to MySQL with PHP , Working with MySQL data , Performing CREATE, DELETE, INSERT operations on MySQL table from PHP Program., Performing SELECT and UPDATE operations on MySQL table from PHP Program, Building Dynamic Content in PHP application	9

V	**JSON** JSON Data Interchange Format -Syntax, Data Types, Object JSON Schema, Manipulating JSON data with PHP **LARAVEL** Laravel Overview- Design Pattern- Laravel Feature, Setting up a Laravel Development Environment-Application structure of Laravel, Laravel Basics Routing -middleware - Controllers, Route Model Binding-Views-Redirections, Blade Templating-echoing data, control structures	9
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U41F	NATURAL LANGUAGE PROCESSING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course enables the learners to understand the concepts of Natural Language Processing. The course covers basic pre-processing steps, language models, text classification using machine learning algorithms, information and relation extraction methods, Information Retrieval, Question Answer Systems and Machine Translation models. This course enables the students to apply techniques and methods to solve challenging real-world problems in NLP.

iii. **COURSE OUTCOMES**

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

CO1	Summarize basic concepts and learning methods for NLP	Understand
CO2	Demonstrate the relevance of pre-processing methods on text data.	Apply
CO3	Compare different language modelling techniques.	Apply
CO4	Make use of NLP techniques in Text Classification and Information Retrieval	Apply
CO5	Explain Information Extraction, Relation Detection, QA Systems and Machine Translation.	Understand

iv. **SYLLABUS**

Introduction to Natural Language Processing, Approaches to NLP, Machine Learning for NLP, Pre-processing and Representation Models, Text Representation, Word Embeddings, Classification and Information Extraction, Text Classification, Named Entity Recognition (NER), Relation Detection and Information Retrieval, Supervised Learning Approaches to Relation Analysis, Evaluation of Relation Analysis systems, QA Systems and Machine Translation, Question-Answering Systems, Statistical Machine Translation.

v. **(a) TEXT BOOKS**

1. Daniel Jurafsky, James H. Martin , "Speech and Language Processing"(2nd and 3rd editions), Pearson Prentice Hall
2. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana," Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems " June 2020 Publisher(s): O'Reilly Media, Inc. ISBN: 9781492054054.

(b) OTHER REFERENCES

1. James Allen, “Natural Language Understanding”, Second Edn , Pearson.
2. Christopher Manning and Hinrich Schutze, Statistical Natural Language Processing, MIT Press.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Introduction to NLP** Introduction to NLP – Tasks and Applications, Language – Building Blocks, Challenges of NLP, Approaches to NLP - Heuristics-Based NLP, Machine Learning for NLP, Machine Learning for NLP – Naïve Bayes Classifier, Logistic Regression, Support Vector Machines – Linearly Separable Data, Support Vector Machines – Linearly Inseparable Data	7
II	**Pre-processing and Representation Models** NLP System Pipeline – Stages – Overview, Data Acquisition, NLP System Pipeline – Text Extraction and Cleanup, NLP System Pipeline – Preprocessing -Sentence segmentation, Word tokenization, Stemming and lemmatization, Feature Engineering, Model Building, Evaluation – Metrices, Post-modeling phase, Text Representation – Vector Space Model, Vectorization Approaches – One hot encoding, Bag of words, Bag of n-grams, TF-IDF, Word Embeddings – Word2Vec- CBOW, SkipGram models	10
III	**Classification and Information Extraction** Text Classification--Text classification applications -Pipeline for building text classification systems, Sentiment Analysis using Naïve Bayes Classifier, Case Studies for Text Classification using Logistic Regression and Support Vector Machines, Information Extraction (IE) and Applications, IE Tasks and the IE Pipeline, Named Entity Recognition (NER) – Ambiguity in NER, NER as Sequence Labeling, Evaluation of NER, Practical NER Systems	9
IV	**Relation Detection and Information Retrieval** Relation Detection and Classification – Supervised Learning Approaches to Relation Analysis, Relation Detection and Classification – Lightly Supervised Approaches to Relation Analysis, Relation Detection and Classification - Evaluation of Relation Analysis systems, Information Retrieval – Term weighting and document scoring, Inverted Index, Evaluation of Information-Retrieval Systems	10
V	**QA Systems and Machine Translation** Question-Answering Systems – Factoid Question Answering, Question Processing, Passage Retrieval, Answer Processing, Evaluation of Factoid Answers, Machine Translation – Why Machine Translation is Hard, Classical Machine Translation, Statistical Machine Translation, The Phrase based Translation model,Alignment in Machine Translation, Decoding for Phrase-based Statistical MT	9
	Total hours	**45**

vi. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

vii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

OPEN ELECTIVE

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41A	INTRODUCTION TO MOBILE COMPUTING	OEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

The purpose of this course is to prepare learners to understand the functionalities and design considerations of mobile computing. The course content is designed to cover the mobile computing architecture, features of different communication systems and major elements of mobile security and next generation computer systems. This course enables the learners to acquire advanced concepts on mobile and ad-hoc networks.

iii. COURSE OUTCOMES

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

CO1	Describe the mobile computing applications, services, design considerations and architectures	Understand
CO2	Identify the technology trends for cellular wireless networks .	Understand
CO3	Summarize the Short Messaging Service and General Packet Radio Service	Understand
CO4	Outline the LAN technologies used in mobile communication.	Understand
CO5	Describe the security protocols and apply suitable security algorithm to secure the communication .	Apply
CO6	Explain the fundamental concepts of next generation mobile networks.	Understand

iv. SYLLABUS

Mobile Computing Architecture, Communication Systems, Satellite communication systems, Mobile computing through telephone ,Short Messaging Service and General Packet Radio Service, Wireless Local Area Networks, Mobile Security and Next Generation Networks.

v. (a) TEXT BOOKS

1. Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology- Application and Service Creation, 2nd Edition, McGraw Hill Education.
2. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009

(b) OTHER REFERENCES

1. Andrew S. Tanenbaum, Computer Networks, 6/e, PHI.
2. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI, New Delhi, 2004.
3. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Mobile Computing Architecture** Introduction to mobile computing – Functions, Devices, Middleware and gateways, Applications, services, limitations, Internet: The ubiquitous network, Three-tier architecture, Three-tier architecture Design considerations for mobile computing ,Design considerations for mobile computing	7
II	**Communication Systems** Evolution of telephony, Multiple access procedures –FDMA, TDMA, CDMA, SDMA, Satellite communication systems – GEO, MEO, LEO, Satellite phones, Interactive Voice Response (IVR) architecture, Overview of voice software, Developing an IVR application (Call flow diagram), Introduction to GSM, Architecture, GSM entities, Call routing, Mobility management, Frequency allocation, Authentication and security	10
III	**Short Messaging Service and General Packet Radio Service** SMS Strengths, Architecture, Short Message Mobile Terminated (SM MT) and Short Message Mobile Originated (SM MO) messages, SMS Architecture - Operator-centric pull, operator-independent push/pull, Value added services, Accessing the SMS bearer Accessing the SMS bearer , GPRS architecture, Network operations Data services, Applications, Limitations, Billing and charging	10
IV	**Wireless Local Area Networks** WLAN Advantages, Evolution, Applications, WLAN Architecture , WLAN Architecture Mobility, Security, Deploying WLAN, WLL Architecture, HIPERLAN, WiFi Vs 3G	8
V	**Mobile Security and Next Generation Networks** Information security – Attacks, Components, Security techniques and algorithms – Stream Vs Block cipher, Symmetric Vs Asymmetric cryptography, Security techniques and algorithms – RSA, Diffie Hellman Key exchange, Security protocols – Secure Socket Layer, Transport Layer Security, Wireless Transport Layer Security, The Converged Scenario, Narrowband to broadband, Orthogonal Frequency Division Multiplexing (OFDM) and Multi Protocol Label Switching (MPLS), Wireless Asynchronous Transfer Mode (WATM) and Multimedia broadcast services	10
	Total hours	**45**

vi. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41B	INTRODUCTION TO DEEP LEARNING	OEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

This course aims to introduce the learner to an overview of the concepts and algorithms involved in deep learning. Basic concepts and application areas of machine learning, deep networks, convolutional neural network and recurrent neural network are covered in this course. This is a foundational program that will help students understand the capabilities, challenges, and consequences of deep learning and prepare them to participate in the development of leading-edge AI technology. They will be able to gain the knowledge needed to take a definitive step in the world of AI.

iii. COURSE OUTCOMES

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

CO1	Demonstrate basic concepts in machine learning.	Understand
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	Understand
CO3	Demonstrate the concept of the feed forward neural network and its training process.	Apply
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	Apply
CO5	Use different neural network/deep learning models for practical applications.	Apply

iv. SYLLABUS

Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting , hyperparameters and validation sets, estimators, bias and variance.

Optimization and Neural Networks: Neural Networks, Multilayer perceptron, activation functions, architecture design. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges. Convolutional Neural Network: Convolutional Neural Networks ,Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.

Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks. Applications – computer vision, speech recognition, natural language processing. Research Areas – Autoencoders, Representation learning, Boltzmann Machines, Deep belief networks.

v. (a)TEXT BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press 2015 ed.

2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, August 2019.
3. Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal. Springer.1st edition, 2018.

(b) OTHER REFERENCES

1. Neural Smithing: Supervised Learning in Feed forward Artificial Neural Networks by Russell Reed, Robert J MarksII, 1st edition, 1999, MIT Press.
2. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, 1st edition, 2018, Packt Publishing Ltd.
3. Hands-On Deep Learning Algorithms with Python by Sudharsan Ravichandran, 1st edition, 2019, Packt Publishing Ltd.
4. Deep Learning with Python by Francois Chollet, 2nd edition, 2018, Manning Publications

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Introduction** Key components - Data, models, objective functions, optimization algorithms, Learning algorithm, Supervised learning- regression, classification, tagging, web search, page ranking ,Recommender systems, Sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Concepts: overfit, underfit, hyperparameters and validation sets, Concepts: Estimators, bias and variance., Demonstrate the concepts of supervised learning algorithms using a suitable platform, Demonstrate the concepts of unsupervised using a suitable platform.	8
II	**Optimization and Neural Networks** Perceptron, Stochastic Gradient descent, Gradient descent solution for perceptron ,Multilayer perceptron, , Activation functions- Sigmoid, tanh, Softmax, ReLU, leaky ReLU Architecture design, Chain rule, back propagation,Gradient based learning, Gradient based optimization, Linear least squares using a suitable platform. Building ML Algorithms and Challenges	9
III	**Convolution Neural Network** Convolution operation, Motivation, pooling ,Convolution and Pooling as an infinitely strong prior ,Variants of convolution functions – multilayer convolutional network, tensors, kernel flipping, downsampling, strides and zero padding. Variants of convolution functions - unshared convolutions, tiled convolution, training different networks, Structured outputs, data types, Efficient convolution algorithms., Case Study: AlexNet, VGG, ResNet.	10
IV	**Recurrent Neural Network** Computational graphs, RNN ,Encoder – decoder sequence to sequence architectures. Deep recurrent networks .Recursive neural networks , Modern RNNs, LSTM and GRU, Practical use cases for RNNs, Demonstrate the concepts of RNN using a suitable platform.	10

V	**Applications and Research** Computer vision. Speech recognition, Natural language processing., Brief introduction on current research areas- Autoencoders, Representation learning. Brief introduction on current research areas- Boltzmann Machines, Deep belief networks.	8
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41C	COMPUTER GRAPHICS	OEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW:**

This course helps the learners to make awareness about strong theoretical concept in computer graphics. It covers the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications. This course enables the learners to develop the ability to create image processing frameworks for different domains and develop algorithms for emerging display technologies.

iii. **COURSE OUTCOMES**

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

CO1	Describe the working principles of graphics devices.	Understand
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms.	Apply
CO3	Demonstrate geometric representations and transformations on 2D & 3D objects	Apply
CO4	Demonstrate the working of line and polygon clipping algorithms	Apply
CO5	Summarize visible surface detection methods and illustrate projection algorithms.	Apply

iv. **SYLLABUS**

Basic Concepts in Computer Graphics. Input devices. Display devices. Line and circle drawing Algorithms. Solid area scan-conversion. Polygon filling. Two dimensional transformations. Windowing, clipping. 3D Graphics, 3D transformations. Projections – Parallel, Perspective. Hidden Line Elimination Algorithms.

v. **(a) TEXT BOOKS**

1. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 2019.
2. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996

(b) OTHER REFERENCES

1. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001
2. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
3. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Basics of Computer Graphics** Basics of Computer Graphics and applications, Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays Flat panel display and its categories.	7
II	**Line drawing, Circle drawing and Filled Area Primitives** DDA Line drawing Algorithm, Bresenham's line drawing algorithm, Midpoint Circle generation algorithm, Bresenham's Circle generation algorithm, Illustration of line drawing and circle drawing algorithms, Scan line polygon filling, Boundary filling and flood filling	10
III	**Geometric transformations** Basic 2D transformations-Translation and Rotation, Basic 2D transformations-Scaling, Reflection and Shearing, Illustration of 2D Transformations, Composite transformations, Matrix representations and homogeneous coordinates, Basic 3D transformations, Illustration of basic 3D transformations	9
IV	**2D Clipping** Window to viewport transformation, Cohen Sutherland Line clipping algorithm, Midpoint subdivision Line clipping algorithm Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon clipping algorithm, Practice problems on Clipping algorithms	10
V	**Three dimensional graphics** Three dimensional viewing pipeline, Projections-Parallel projections, Projections- Perspective projections, Visible surface detection algorithms- Back face detection., Depth buffer algorithm, Depth buffer algorithm, Scan line visible surface detection algorithm, Scan line visible surface detection algorithm, A buffer algorithm	9
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41D	PYTHON FOR ENGINEERS	OEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The objective of the course is to provide learners an insight into Python programming in a scientific computation context and develop programming skills to solve engineering problems. It covers programming environment, important instructions, data representations, intermediate level features, Object Oriented Programming and file data processing of Python. This course lays the foundation to scientific computing, develop web applications, Machine Learning, and Artificial Intelligence-based applications and tools, Data Science and Data Visualization applications.

iii. **COURSE OUTCOMES**

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

CO1	Explain the data types, operators and keywords in Python.	Apply
CO2	Illustrate uses of conditional and iterative statements in Python programs.	Apply
CO3	Develop programs by utilizing the Python programming constructs functions and data structures in Python.	Apply
CO4	Implement Object Oriented programs using exception handling.	Apply
CO5	Analyze, Interpret, and Visualize data according to the target application.	Apply
CO6	Implement programs in Python to process data stored in files by utilizing Numpy, Matplotlib, and Pandas.	Apply

iv. **SYLLABUS**

Basics of Python, using editors, detecting and correcting syntax errors, using built in functions and modules in math module, Testing the control statements, Lazy evaluation. Functions and Python Data Structures, working with tuples-Sets-list- dictionaries. Object Oriented Programming Structuring classes with Inheritance and Polymorphism, abstract Classes, exceptions. Visualization and File handling using packages.

v.(a) TEXT BOOKS

1. Kenneth A Lambert., Fundamentals of Python: First Programs, 2/e, Cengage Publishing, 2016
2. David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2021

(b) OTHER REFERENCES

1. Wes McKinney, Python for Data Analysis, 2/e, Shroff / O'Reilly Publishers, 2017
2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016

3. Michael Urban and Joel Murach, Python Programming, Shroff/Murach, 2016
4. David M.Baezly, Python Essential Reference. Addison-Wesley Professional; 4/e, 2009.
5. Charles Severance. Python for Informatics: Exploring Information,
6. http://swcarpentry.github.io/python-novice-gapminder/

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Basics of Python** Getting Started with Python Programming: Running code in the interactive shell Editing, Saving, and Running a script, Using editors: IDLE, Jupyter, Basic coding skills: Working with data types, Numeric data types and Character sets, Keywords, Variables and Assignment statement, Operators, Expressions, Working with numeric data, Type conversions, Comments in the program, Input Processing, and Output. Formatting output, How Python works. Detecting and correcting syntax errors. Using built in functions and modules in math module. Control statements : Selection structure, if-else, if elif else, Iteration structure - for, while Testing the control statements, Lazy evaluation.	9
II	**Functions and Python Data Structures** Functions: Hiding redundancy and complexity, Arguments and return values, Variable scopes and parameter passing, Named arguments, Main function, Working with recursion, Lambda functions, Strings - String function, Lists - Basic list Operations and functions, List of lists, Slicing, Searching and sorting list, List comprehension, Work with tuples. Sets, Dictionaries - Dictionary functions, dictionary literals, adding and removing keys, Accessing and replacing values, traversing dictionaries, reverse lookup	9
III	**Object Oriented Programming** Design with classes : Objects and Classes, Methods, Instance Variables Constructor, Accessors, and Mutators, Structuring classes with Inheritance, Polymorphism, Abstract Classes, Exceptions: Handle a single exception, Handle multiple exception	8
IV	**Visualization and File handling** Plotting - An Interactive Session with PyPlot, Basic Plotting, Logarithmic Plots, More Advanced Graphical Output, Plots with multiple axes, Mathematics and Greek symbols, The Structure of matplotlib, Contour and Vector Field Plots File Processing -The os and sys modules, Introduction to file I/O, Reading and writing text files, Working with CSV files	9
V	**Scientific Computing** Numerical Routines: SciPy and NumPy - Basics, Creating arrays, Arithmetic, Slicing, Matrix Operations, Special Functions, Random Numbers, Linear Algebra, Solving Nonlinear Equations Numerical Integration, Solving ODEs, Data Manipulation and Analysis: Pandas - Reading Data from Files Using Pandas, Data Structures - Series and DataFrame, Extracting Information from a DataFrame, Grouping and Aggregation	10
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of SeriesTests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0U41E	OBJECT ORIENTED CONCEPTS	OEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course covers Object Oriented Principles, Object Oriented Programming in Java, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course provides learners the basics to develop Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

iii. COURSE OUTCOMES

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

CO1	Develop Java programs using the object-oriented concepts - classes, objects, constructors, data hiding, inheritance and polymorphism.	Apply
CO2	Utilize data types, operators, control statements, built in packages & interfaces, Input/output Streams and Files in Java to develop programs .	Apply
CO3	Illustrate how robust programs can be written in Java using exception handling mechanism	Apply
CO4	Develop application programs in Java using multithreading .	Apply
CO5	Develop Graphical User Interface based application programs by utilizing event handling features and Swing in Java	Apply

iv. SYLLABUS

Object Orientation and Java basics: Object Orientation Principles, Introduction to Java Primitive Data types, Arrays, Strings, Vector class.

Core Java Fundamentals: Operators, Control Statements, Object Oriented Programming in Java - Class Fundamentals, Overloading, Recursion, Access Control, Command-Line Arguments.

More features of Java: Inheritance - The Keyword *super*, protected Members, Method Overriding, Abstract Classes and Methods, Packages and Interfaces, Exception Handling.

Advanced features of Java:Input/Output - I/O Basics Reading and Writing Files, String Handling, Comparison of String Buffer and String.

GUI Programming, Event Handling and Multithreaded Programming: Multithreaded Programming, Event Handling - Delegation Event Model, Using the Delegation Model. Swing Fundamentals - Model View Controller (MVC), Exploring Swing - JFrame, JLabel, JButton, JTextField.

v. (a)TEXT BOOKS

1. Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

(b) OTHER REFERENCES

1. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11/e, Pearson, 2018.
2. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
3. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
4. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
5. Sierra K., Head First Java, 2/e, O'Reilly, 2005.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Object Orientation and Java basics** Object Orientation Principles – Object and Class, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of using Object orientation, Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues, Primitive Data types - Integers, Floating Point Types, Characters, Boolean, Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class	8
II	**Core Java Fundamentals** Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence, Control Statements - Selection Statements, Iteration Statements and Jump Statements, Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, static Members, Command-Line Arguments, Variable Length Arguments	9
III	**More features of Java** Inheritance - Super class, Sub class, the keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using final with Inheritance, Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces, Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally	9

IV	**Advanced features of Java** Input/Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Working with Files , Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, Using valueOf( ), Comparison of StringBuffer and String.	9
V	**GUI Programming, Event Handling and Multithreaded Programming** Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads, Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model, Swing fundamentals, Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Exploring Swing –JFrame, JLabel, JButton, JTextField	10
	Total hours	**45**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of SeriesTests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

MINOR

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CSOM49A	MINI PROJECT	PWS	0	1	6	4	2020

i. **PRE-REQUISITE :** Nil

ii. **COURSE OVERVIEW**

The objective of this course is to apply the fundamental concepts of different courses learned in respective Minor Streams: Software Engineering, Machine Learning and Networking. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification &design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

iii. **COURSE OUTCOMES**

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

CO1	Identify technically and economically feasible problems	Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions.	Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques	Apply
CO4	Prepare technical report and deliver presentation	Apply
CO5	Apply engineering and management principles to achieve the goal of the project	Apply

iv. **COURSE PLAN**

Students are expected to follow the following steps.

1. Review of Literature and Identification of a problem
2. Create an abstract with a problem statement, solution approach, technology stack, team, etc.
3. Create Requirements Specification
4. Create Design Document . This may include designs like,
    a. System Architecture Design
    b. Application Architecture Design
    c. GUI Design
    d. API Design
    e. Database Design
    f. Technology Stack

5. Deployment, Test Run & Get Results
6. Prepare Project Report

v. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	1 Hour

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H40A	CYBER FORENSICS	VAC	3	1	0	4	2020

i. **PRE-REQUISITE :** Nil

ii. **COURSE OVERVIEW**

The course on Cyber Forensics aims at exploring the basics of Cyber Forensics and Cyber security, the forensic investigation process and principles and the different types of cybercrimes and threats. This course also focuses on the forensic analysis of File systems, the Network, the Windows and Linux Operating systems. The course gives a basic understanding of the forensics analysis tools and a deep understanding of Anti forensics practices and methods. All the above aspects are dealt with case studies of the respective areas.

iii. **COURSE OUTCOMES**

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

CO1	Explain thebasic concepts in Cyber Forensics, Forensics Investigation Process and Cyber security	Understand
CO2	Infer the basic concepts of File Systems and its associated attribute definitions	Understand
CO3	Utilize the methodologies used in data analysis and memory analysis for detection of artefacts.	Apply
CO4	Identify web attacks and detect artefacts using OWASP and penetration testing.	Apply
CO5	Summarize anti-forensics practices and data hiding methods .	Understand

iv. **SYLLABUS**

Computer Forensics: History of computer forensics, Forensics Investigation Principles - Forensic Protocol for Evidence Acquisition - Digital Forensics -Standards and Guidelines - Digital Evidence – Data Acquisition - storage formats for digital evidence, determining the best acquisition method, contingency planning for image acquisitions, Cyber Forensics tools-Cyber Security: Cyber crimes, Recent Data Breaches - Recent Cyber security Trends. File system Analysis: FAT and NTFS concepts and analysis -File system category, Content category, Metadata category, File name category, Application category, Application-level search techniques. Windows Forensics: Live Response- Data Collection-

Locard's Exchange Principle, Order of Volatility Volatile and Non Volatile Data Live-Response Methodologies. Linux Forensics: Live Response Data Collection, Data Analysis, Reconnaissance Tools. Network Forensics: The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Anti Forensics.

v. (a) TEXT BOOKS

1. Bill Nelson, Amelia Phillips and Christopher Steuart, Computer forensics - Guide to Computer Forensics and Investigations, 4/e, Course Technology Inc.
2. Brian Carrier, File System Forensic Analysis, Addison Wesley, 2005.
3. Harlan Carvey, Windows Forensic Analysis DVD Toolkit, 2/e, Syngress.
4. Cory Altheide, Todd Haverkos, Chris Pogue,Unix and Linux Forensic Analysis DVD Toolkit, 1/e, Syngress.
5. William Stallings,Network Security Essentials Applications and Standards, 4/e, Prentice Hall
6. Eric Maiwald, Fundamentals of Network Security, McGraw-Hill, 2004.

(b) OTHER REFERENCES

1. Michael. E. Whitman, Herbert. J. Mattord, Principles of Information Security, Course Technology, 2011.
2. William Stallings, Cryptography and Network Security Principles and Practice, 4/e, Prentice Hall.
3. Niranjan Reddy, Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations, Apress, 2019.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Cyber Forensics and Cyber Security** History of computer forensics, preparing for computer investigations, Understanding Public and private investigations- Forensics Investigation Principles, Forensic Protocol for Evidence Acquisition, Digital Forensics - Standards and Guidelines - Digital Evidence, Data Acquisition - storage formats for digital evidence, determining the best acquisition method, Contingency planning for image acquisitions, Cyber Forensics tools, Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cybercrimes, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends, Case Study: Sim Swapping Fraud, ATM Card Cloning, Case Study: Hacking email for money, Google Nest Guard, Email Crimes, Phishing, Types of Phishing	13
II	**File System Forensics** FAT and NTFS concepts and analysis, File system category, Content category, Metadata category, File name category, Application category,	13

	Application-level search techniques, Specific file systems, File recovery, Consistency check, FAT data structure-Boot sector, FAT 32 FS info, directory entries, Long file name directory entries	
III	**Operating System Forensics** Live Response- Data Collection- Locard's Exchange Principle, Order of Volatility, Volatile and Non Volatile Data, Live-Response Methodologies: Data Analysis- Agile Analysis, Windows Memory Analysis, Rootkits and Rootkit detection, Linux Forensics: Live Response Data Collection, Prepare the Target Media, Format the Drive, Gather Volatile Information, Acquiring the Image, Initial Triage, Data Analysis- Log Analysis, Keyword Searches, User Activity, Data Analysis- Network Connections, Running Processes, Open File Handlers, The Hacking Top Ten, Reconnaissance Tools	14
IV	**Network Forensics** OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Web Attack Forensics, OWASP Top 10, Web Attack Tests, Penetration Testing-1, Penetration Testing.-2	10
V	**Anti-Forensics** Anti-forensic Practices - Data Wiping and Shredding, Data Remanence, Degaussing, Trail Obfuscation: Spoofing, Data Modification, Role of Encryption in Forensics, Data Hiding: Steganography and Cryptography, Anti-forensics Detection Techniques	10
	Total hours	60

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of SeriesTests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H40B	REINFORCEMENT LEARNING	VAC	3	1	0	4	2020

i. PRE-REQUISITE : Nil

ii. COURSE OVERVIEW

This course covers fundamental principles and techniques in reinforcement learning. Reinforcement learning is concerned with building programs that learn how to predict and act in a stochastic environment, based on past experience. Applications of reinforcement learning range from classical control problems, such as power plant optimization or dynamical system control, to game playing, inventory control, and many other fields. Topics include Markov decision process, dynamic programming, Monte Carlo, temporal difference, function approximation reinforcement learning algorithms, and applications of reinforcement learning. This course enables the leaners to apply reinforcement learning on real world applications and research problems.

iii. COURSE OUTCOMES

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

CO 1	Solve computational problems using probability and random variables.	Apply
CO 2	Apply policy iteration and value iteration reinforcement learning algorithms.	Apply
CO 3	Employ Monte Carlo reinforcement learning algorithms.	Apply
CO 4	Apply temporal-difference reinforcement learning algorithms.	Apply
CO 5	Apply on-policy and off-policy reinforcement learning algorithms with function approximation.	Apply

iv. SYLLABUS

Review Of Probability Concepts, Markov Decision Process, Finite Markov Decision Processes, Prediction And Control, Temporal-Difference (TD) Methods For Model Free Prediction And Control, Sarsa, Function Approximation Method, Eligibility Traces ,Policy Gradient Methods, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor–Critic Methods.

v. (a) TEXT BOOKS

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction,2nd Edition
2. Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Edition,

(b) OTHER REFERENCES

1. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds
2. Algorithms for Reinforcement Learning, Szepesvari (2010), Morgan & Claypool.
3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig
4. Mathematical Statistics and Data Analysis by John A. Rice,University of California, Berkeley, Third edition, published by Cengage.
5. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Review of Probability Concepts** Axioms of probability, concepts of random variables, Probability mass function, Probability density function, Cumulative density functions, Expectation of random variables, Joint and multiple random variables, Conditional and marginal distributions Correlation and independence	10
II	**Markov Decision Process** Introduction to Reinforcement Learning(RL) terminology - Examples of RL, Elements of RL, Limitations and Scope of RL, Finite Markov Decision Processes, The Agent Environment Interface Goals and Rewards, Returns and Episodes, Policies and Value Functions, Optimal Policies and Optimal Value Functions, Optimal Policies and Optimal Value Functions	13
III	**Prediction And Control** Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-policy Monte Carlo Control	13
IV	**Temporal-Difference (Td) Methods TB-1** TD Prediction, Advantages of TD Prediction Methods Optimality of TD (0), Sarsa: On-policy TD Control, Q-learning: Off-policy TD Control, Expected Sarsa, n-step TD Prediction, n-step Sarsa, n-step Off-policy Learning Off-policy Learning Without Importance Sampling: The n-step Tree Backup Algorithm	12

V	**Function Approximation Method TB-1** Value-function Approximation, The Prediction Objective, Stochastic-gradient Methods, Linear Methods, The Lambda-return , TD(Lambda), n-step Truncated Lambda-return Methods, Sarsa(Lambda), Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient REINFORCE with Baseline, Actor–Critic Methods	12
	Total hours	**60**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1H40C	LOGIC FOR COMPUTER SCIENCE	VAC	3	1	0	4	2020

i. **PRE-REQUISITE :** Nil

ii. **COURSE OVERVIEW**

This course enables the learners to understand the concepts of various logics used in computer science. The course covers the standard and most popular logics such as propositional logic, predicate logic, linear temporal logic, computation tree logic, Hoare logic and modal logic. This course helps the students to develop solutions for specification and verification of real world systems.

iii. **COURSE OUTCOMES**

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

CO1	Explain the concepts of Predicate Logic, Propositional Logic, Linear Temporal Logic, Computation Tree Logic, Hoare Logic and Modal Logic as a formal language.	Understand
CO2	Develop proofs to show the satisfiability, validity and equivalence of logic formulas.	Apply
CO3	Illustrate model checking and program verification to prove correctness of systems	Apply
CO4	Demonstrate Alloy Analyzer to model and analyze software systems.	Apply
CO5	Demonstrate New Symbolic Model Verifier (NuSMV) as a model checking tool to check the validity of temporal logic formulas.	Apply

iv. **SYLLABUS**

Propositional Logic: Declarative Sentences, Natural Deduction, Propositional Logic as a Formal Language, Semantics of Propositional Logic, Normal Forms, SAT Solvers.

Predicate Logic: The Need of a Richer Language, Predicate Logic as a Formal Language, Proof Theory of Predicate Logic, Semantics of Predicate Logic, Undesirability of Predicate Logic, Expressiveness of Predicate Logic.

Verification by Model Checking: Motivation for Verification, Linear Time Temporal Logic (LTL), Model Checking Systems, Tools, Properties, Branching Time Logic, Computation Tree Logic (CTL) and the Expressive Powers of LTL and CTL, Model Checking Algorithms, The Fixed Point Characterization of CTL.

Program Verification: Why Should We Specify and Verify Code, A Framework for Software Verification, Proof Calculus for Partial Correctness, Proof Calculus for Total Correctness, Programming by Contract.

Modal Logics and Agents: Modes of Truth, Basic Modal Logic, Logic Engineering, Natural Deduction, Reasoning about Knowledge in a Multi-Agent System.

v. (a) TEXT BOOKS

1. Michael Huth and Mark Ryan, Logic in Computer Science, 2/e, Cambridge University Press, 2004.

(b) OTHER REFERENCES

1. Daniel Jackson, Software Abstractions, MIT Press, 2011.
2. Roberto Cavada, Alessandro Cimatti, Gavin Keighren, Emanuele Olivetti, Marco Pistore and Marco Roveri, NuSMV 2.6 Tutorial (available at *https://nusmv.fbk.eu*).
3. Tutorial for Alloy Analyzer 4.0 (available at *https://alloytools.org/tutorials/online/*).

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Propositional Logic** Declarative Sentences, Natural Deduction, Rule for Natural Deduction, Derived Rules, Natural Deduction in Summary Provable Equivalence, Proof by Contradiction. Propositional Logic as a Formal language, Semantics of Propositional Logic – The Meaning of Logical Connectives, Soundness of Propositional Logic, Completeness of Propositional Logic (Proof not required), Semantic Equivalence, Satisfiability and Validity, Normal Forms – Conjunctive Normal Forms and Validity, Horn Clauses and Satisfiability, SAT Solvers – A Linear Solver, A Cubic Solver	12
II	**Predicate Logic** The Need of a Richer language, Predicate Logic as a Formal Language – Terms, Formulas, Free and Bound Variables, Substitution, Proof Theory of Predicate Logic – Natural Deduction Rules, Proof Theory of Predicate Logic – Quantifier Equivalences, Semantics of Predicate Logic – Models, Semantic Entailment, The Semantics of Equality, Undecidabilty of Predicate Logic (no proof required), Expressiveness of Predicate Logic – Existential Second Order Logic, Universal Second Order Logic, Micromodelsof Software – State Machines, A Software Micromodel (Alloy) ,A Software Micromodel (Alloy)	12

III	**Verification by Model Checking** Motivation for Verification, Linear Time Temporal Logic (LTL) – Syntax, Semantics of LTL – Practical Patterns of Specifications, Important Equivalences between LTL Formulas, Adequate Sets of Connectives for LTL, Introduction to model checking, Model Checking Systems, Tools, Properties, Model checking example: Mutual Exclusion The New Symbolic Model Verifier(NuSMV), Model Checker- Introduction, Mutual Exclusion Revisited, The NuSMV ModelChecker – The Ferryman, The Alternating Bit Protocol, Branching Time Logic – Syntax of Computation Tree Logic (CTL), Semantics of CTL, Practical Patterns of Specification, Important Equivalences betweenCTL Formulas, Adequate Sets of CTL Connectives, CTL and the Expressive Powers of LTL and CTL – Boolean Combinations of Temporal Formulas in CTL, Model-Checking Algorithms – The CTL Model Checking Algorithm,CTL Model Checking with Fairness, The LTL Model Checking Algorithm(Algorithm only)	14
IV	**Program Verification** Introduction to Program Verification, Need of Specification and Verification of Code, A Framework for Software Verification – A Core Programming Language, Hoare Triples, A Framework for Software Verification – Partial and Total Correctness, Program Variables and Logical Variables, Proof Calculus for partial Correctness – Proof Rules, Proof Calculus for partial Correctness – Proof Tableaux, Proof Calculus for partial Correctness – A Case Study: Minimal-Sum Section, Proof Calculus for Total Correctness, Programming by Contract	10
V	**Modal Logics and Agents** Modes of Truth, basic Modal Logic – Syntax, Basic Modal Logic – Semantics, Logic Engineering – The Stock of Valid Formulas, Important Properties of the Accessibility Relation, Logic Engineering – Correspondence Theory, Some Modal Logics, Natural Deduction Reasoning about Knowledge in a Multi-Agent System –Examples (The Wise - Man Puzzle, The Muddy – Children Puzzle), The Modal Logic KT45n, Natural Deduction for KT45n Formalizing the Examples (The Wise - Man Puzzle, The Muddy – Children Puzzle)	12
	Total hours	**60**

vii. CONTINUOUS ASSESSMENT EVALUATION PATTERN

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. MARK DISTRIBUTION

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

SEMESTER VIII

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U40B	DISTRIBUTED COMPUTING	PCC	2	1	0	3	2020

i. PRE-REQUISTE : NIL

ii. COURSE OVERVIEW

The purpose of this course is to understand the system models, algorithms and protocols that allow computers to communicate and coordinate their actions to solve a problem. This course helps the learner to understand the distributed computation model and various concepts like global state, termination detection, mutual exclusion, deadlock detection, shared memory, failure recovery, consensus, file system. It helps the learners to develop solutions to problems in distributed computing environment.

iii. COURSE OUTCOMES

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

CO1	Summarize various aspects of distributed computation model and logical time.	Understand
CO2	Illustrate election algorithm, global snapshot algorithm and termination detection algorithm.	Apply
CO3	Compare token based, non-token based and quorum based mutual exclusion algorithms.	Understand
CO4	Recognize the significance of deadlock detection and shared memory in distributed systems	Understand
CO5	Explain the concepts of failure recovery and consensus.	Understand
CO6	Illustrate distributed files system architectures.	Understand

iv. SYLLABUS

Distributed systems basics and Computation model: Design issues, Challenges and applications. A model of distributed computations, Models of process communications.

Election algorithm, Global state and Termination detection: Logical time, Leader election algorithm, Global state and snapshot recording algorithms, Termination detection.

Mutual exclusion and Deadlock detection: Distributed mutual exclusion algorithms. , Quorum-based mutual exclusion algorithms. Token-based algorithm. Deadlock detection in distributed systems.

Distributed shared memory and Failure recovery: Shared memory mutual exclusion. Check pointing and rollback recovery

Consensus and Distributed file system: The Byzantine agreement and other problems, Agreement in (message-passing) synchronous systems with failures – Consensus algorithm for crash failures. Distributed file system – File service architecture, Case studies.

v. (a)TEXT BOOKS

1. Ajay D. Kshemkalyani and Mukesh Singhal, Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press, 2011.

(b) OTHER REFERENCES

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair. Distributed Systems: Concepts and Design, Addison Wesley, Fifth edition.
2. Kai Hwang, Geoffrey C Fox, Jack J Dongarra, Distributed and Cloud Computing – From Parallel Processing to the Internet of Things, Morgan Kaufmann Publishers, 2012.
3. Sukumar Ghosh, Distributed Systems: An Algorithmic Approach, CRC Press, Second edition, 2015.
4. Maarten Van Steen, Andrew S. Tanenbaum, Distributed Systems, Prentice Hall of India,Third edition, 2017.
5. Randy Chow and Theodore Johnson, Distributed Operating Systems and Algorithm Analysis, Pearson Education India, First edition, 2009.
6. Valmir C. Barbosa, An Introduction to Distributed Algorithms, MIT Press, 2003.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Distributed systems basics and Computation model** Distributed System – Definition, Relation to computer system components , Primitives for distributed communication, Design issues, challenges and applications, Design issues, challenges and applications, A model of distributed computations – Distributed program, Model of distributed executions, Models of communication networks, Global state of a distributed system, Cuts of a distributed computation, Cuts of a distributed computation, Past and future cones of an event, Models of process communications.	9
II	**Election algorithm, Global state and Termination detection** Logical time – A framework for a system of logical clocks, Scalar time, Vector time, Leader election algorithm – Bully Algorithm, Ring Algorithm, Global state and snapshot recording algorithms – System model and definitions, Snapshot algorithm for FIFO channels – Chandy Lamport algorithm, Termination detection – System model of a distributed computation, Termination detection using distributed snapshots, Termination detection by weight throwing, Spanning tree-based algorithm	10

III	**Mutual exclusion and Deadlock detection** Distributed mutual exclusion algorithms – System model, Lamport's algorithm, Ricart–Agrawala algorithm, Quorum-based mutual exclusion algorithms – Maekawa's algorithm, Token-based algorithm – Suzuki–Kasami's broadcast algorithm, Deadlock detection in distributed systems-System model, Deadlock handling strategies, Issues in deadlock detection Models of dead locks	8
IV	**Distributed shared memory and Failure recovery** Distributed shared memory – Abstraction and advantages, shared memory mutual exclusion – Lamport's bakery algorithm, Checkpointing and rollback recovery – System model, consistent and inconsistent states different types of messages, Issues in failure recovery, checkpoint based recovery, log based roll back recovery, log based roll back recovery	10
V	**Consensus and Distributed file system** Consensus and agreement algorithms – Assumptions, The Byzantine agreement and other problems, agreement in (message-passing) synchronous systems with failures –Consensus algorithm for crash failures, Agreement in (message-passing) synchronous systems with failures –Consensus algorithm for crash failures, Distributed File System – File Service Architecture, Case Studies: Sun Network File System, Andrew File System.	8
	Total hours	**45**

vii. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

viii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U40C	Comprehensive Course Viva	PCC	1	0	0	1	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : **25**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U49C	PROJECT PHASE II	PCC	0	0	12	4	2020

i. PREAMBLE

The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

ii. COURSE OVERVIEW

The aim of this course is to apply engineering knowledge in solving practical problems, to foster innovation in design of products, processes or systems, and to develop creative thinking in finding viable solutions to engineering problems.

iii. COURSE OUTCOMES

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

CO1	Model and solve real world problems by applying knowledge across domains	Apply
CO2	Develop products, processes or technologies for sustainable and socially relevant applications	Apply
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks	Apply
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms	Apply
CO5	Identify technology/research gaps and propos innovative/creative solutions	Analyze
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms	Apply

iv. Phase 2 TARGETS:

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.

- Preparing a report in the standard format for being evaluated by the Department Assessment Board.

Final project presentation and viva voce by the assessment board including the external expert.

v. Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Mark s**	**Poor**	**Fair**	**Very Good**	**Outstan ding**
2-a	Novelty of idea, and Implementation scope[CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the propose idea can be implemented. There is still lack of originality in the work done so far by the team. The project is regularly done theme/topic without any freshness in terms or specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly nove idea. Original work which is not ye reported anywhere else Evidence fo ingenious way of innovation which i also Implementable. Could be a patentable / publishable work.
			(0 -1 Marks)	(2 -3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind Members are still having no clue on what to do.	Task allocation done, but no effectively, some members do not have any idea of the tasks assigned Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries identification of tasks through discussion etc. However, the task distribution seem to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individua members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 -1 Marks)	(2 -3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials resources to use in the project. The students do not have any idea on the	There is some improvement in the primary plan prepared during phase There were some ideas on the materials /resources required, but no really thought out. The students have some idea on the finances required but they have not formalized a budge	Good evidence of planning done and being followed up to a good extent after phase I Materials were listed and thought out but the plan wasn't followed completely Schedules were prepared, but no detailed, and needs improvement. Project journal is presented but it is neithe	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement is applicable is progressing well. Tasks are

			budget required even after the end of phase - I. No project journal kept of the journal.	plan. Schedules were not prepared The project journal has no useful details on the project.	complete nor updated regularly.	updated and incorporated in the schedule A well-kept project journal showed evidence for al the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation-2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures issues observed. Any kind of observations or studies are not made	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 - 3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-i	Innovation / novelty /Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 -3 Marks)	(4 - 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident References are not cited Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues Organization of the report is good Mostly consistently formatted. Most of the references/sources are cited acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

PROGRAM ELECTIVE III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U42A	DEEP LEARNING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

Deep Learning is the recently emerged branch of machine learning, particularly designed to solve a wide range of problems in Computer Vision and Natural Language Processing. In this course, the building blocks used in deep learning are introduced. Specifically, neural networks, deep neural networks, convolutional neural networks and recurrent neural networks. Learning and optimization strategies such as Gradient Descent, Nesterov Accelerated Gradient Descent, Adam, AdaGrad and RMSProp are also discussed in this course. This course will help the students to attain sound knowledge of deep architectures used for solving various Vision and NLP tasks. In future, learners can master modern techniques in deep learning such as attention mechanisms, generative models and reinforcement learning.

iii. **COURSE OUTCOMES**

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

CO1	Illustrate the basic concepts of neural networks and its practical issues	Apply
CO2	Outline the standard regularization and optimization techniques for deep neural network	Understand
CO3	Implement the foundation layers of CNN (pooling, convolutions	Apply
CO4	Implement a sequence model using recurrent neural networks	Apply
CO5	Use different neural network/deep learning models for practical applications.	Apply

iv. **SYLLABUS**

Introduction to neural networks, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques. Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.

Recurrent neural networks, LSTM and GRU.

Applications – computer vision, speech recognition, natural language processing, common word embedding, Research Areas – auto encoders, representation learning, boltzmann machines, deep belief networks.

v. (a) TEXT BOOKS

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C.
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc

(b) OTHER REFERENCES

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018

vi. COURSE PLAN

Module	Contents	No. of Hours
I	Introduction to neural networks -Single layer perceptrons, Multi-Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. , Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.	8
II	Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.	10
III	Convolutional Neural Networks – convolution operation, motivation, pooling, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types, efficient convolution algorithms.	9
IV	Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU.	9
V	Applications – computer vision, speech recognition, natural language	9

	processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks.	
	Total hours	**45**

vii. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

viii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U42B	PROGRAMMING PARADIGMS	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The course provides the learners a clear understanding of the main constructs of contemporary programming languages and the various systems of ideas that have been used to guide the design of programming languages. This course covers the concepts of Names, Bindings & Scope, Statement-Level Control Structures, Sub Programs, Support for Object Oriented Programming, Exception Handling, Concurrency Control, Functional Programming and Logic Programming. This course helps the learners to equip with the knowledge necessary for the critical evaluation of existing and upcoming programming languages. It also enables the learner to choose the most appropriate language for a given programming task, apply that language's approach to structure or organize the code, classify programming languages based on their features and to design new generation languages.

iii. **COURSE OUTCOMES**

CO1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages	Understand
CO2	Explain the characteristics of data types and variables	Apply
CO3	Comprehend how control flow structures and subprograms help in developing the structure of a program to solve a computational problem	Apply
CO4	Explain the characteristics of Object-Oriented Programming Languages	Understand
CO5	Compare concurrency constructs in different programming languages	Understand

iv. **SYLLABUS**

Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments. Data Type Checking, Strong Typing, Type Equivalence. Expressions – Arithmetic Expressions , Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short- Circuit Evaluation. Assignment - Assignment Statements, Mixed-mode Assignment. Statement-Level Control Structures, Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Closures, Co-routines. Support for Object Oriented Programming, Exception Handling – Basic Concepts, Design Issues. Event Handling - Introduction to Event Handling.

Concurrency — Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages. Logic Programming Languages – Basic Elements of Prolog, Applications of Logic Programming.

v.(a) TEXT BOOKS

1. Robert W Sebesta, Concepts of Programming Languages, 10th Edition, Pearson.
2. Scott M L, Programming Language Pragmatics, 3rd Edition, Morgan Kauffman Publishers.

(b) OTHER REFERENCES

1. Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edition, Cengage Learning.
2. Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edition. –TMH.
3. Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edition., Pearson Education.
4. David A. Watt, Programming Language Design Concepts, Wiley Dreamtech.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	Introduction: Reasons for studying Concepts of programming languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade- offs, Implementation Methods, Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments	7
II	Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer and Reference Types, Implementation of pointer and reference types, Type Checking, Strong Typing, Type Equivalence, Expressions and Assignment Statements, Arithmetic Expressions, Overloaded Operators, Type Conversions ,Relational and Boolean Expressions, Short-Circuit Evaluation, Assignment Statements, Mixed-mode Assignment	10
III	Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands, Subprograms: Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines	10
IV	Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object-Oriented Constructs, Exception Handling – Basic Concepts, Exception Handling - Design Issues	9

V	Subprogram Level Concurrency, Semaphores, Monitors, Message Passing, Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages, Basic elements of Prolog, Applications of Logic Programming	9
	Total hours	**45**

vii. Continuous Assessment Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U42C	CRYPTOGRAPHY	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course helps the learners to explore the fundamental concepts of symmetric and asymmetric cipher models. This course covers fundamental concepts of authentication protocols, network security protocols and web security protocols. The concepts covered in this course enable the learners in effective use of cryptographic techniques for securing network applications.

iii. **COURSE OUTCOMES**

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

CO1	Summarize different classical encryption techniques	Understand
CO2	Identify mathematical concepts for different cryptographic algorithms	Understand
CO3	Demonstrate cryptographic algorithms for encryption/key exchange.	Apply
CO4	Summarize different authentication and digital signature schemes.	Understand
CO5	Identify security issues in network, transport and application layers and outline appropriate security protocols.	Understand

iv. **SYLLABUS**

Authentication Protocols: Symmetric Cipher Models- Substitution techniques- Transposition techniques- Rotor machines-Steganography. Simplified DES- Block Cipher principles- The Data Encryption Standard, Strength of DES-Differential and linear Cryptanalysis. Block Cipher Design principles- Block Cipher modes of operations.

E-mail Security: IDEA: Primitive operations- Key expansions- One round, Odd round, Even Round- Inverse keys for decryption. AES: Basic Structure- Primitive operation- Inverse Cipher- Key Expansion, Rounds, Inverse Rounds. Stream Cipher –RC4.

Network Layer Security and Web Security: Public key Cryptography: - Principles of Public key Cryptography Systems, Number theory- Fundamental Theorem of arithmetic, Fermat's Theorem, Euler's Theorem, Euler's Totient Function, Extended Euclid's Algorithm, Modular arithmetic. RSA algorithm- Key Management - Diffie-Hellman Key Exchange, Elliptic curve cryptography.

Real-time Security and Application Layer Security: Authentication requirements- Authentication functions- Message authentication codes- Hash functions- SHA -1, MD5, Security of Hash functions and MACs- Authentication protocols-Digital signatures-Digital signature standards.

System Security and Wireless Security: Network security: Electronic Mail Security: Pretty good privacy- S/MIME. IP Security: Architecture - authentication Header-Encapsulating Security payload- Combining Security associations- Key management. Web Security: Web Security considerations- secure Socket Layer and Transport layer Security- Secure electronic transaction. Firewalls-Packet filters- Application Level Gateway- Encrypted tunnels

v.(a) TEXT BOOKS

1. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw-Hill. 2010
2. William Stallings, Cryptography and Network Security, Pearson Education, 2014.

(b) OTHER REFERENCES

1. B. Schneier , Applied Cryptography, Protocols, Algorithms, and Source Code in C, 2 ndEdn, Wiley, 1995.
2. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, PHI, 2002

vi. COURSE PLAN

Module	Contents	No. of Hours
I	Symmetric Cipher Models- Substitution techniques-Transposition techniques- Rotor machines-Steganography. Simplified DES- Block Cipher principles- The Data Encryption Standard, Strength of DES- Differential and linear Cryptanalysis. Block Cipher Design principles- Block Cipher modes of operations.	8
II	IDEA: Primitive operations- Key expansions- One round, Odd round, Even Round- Inverse keys for decryption. AES: Basic Structure- Primitive operation- Inverse Cipher- Key Expansion, Rounds, Inverse Rounds. Stream Cipher –RC4.	9
III	Public key Cryptography: - Principles of Public key Cryptography Systems, Number theory- Fundamental Theorem of arithmetic, Fermat’s Theorem, Euler’s Theorem, Euler’s Totient Function, Extended Euclid’s Algorithm, Modular arithmetic. RSA algorithm- Key Management - Diffie-Hellman Key Exchange, Elliptic curve cryptography	10
IV	Authentication requirements- Authentication functions- Message authentication codes- Hash functions- SHA -1, MD5, Security of Hash functions and MACs- Authentication protocols-Digital signatures-Digital signature standards.	9

V	Network security: Electronic Mail Security: Pretty good privacy- S/MIME. IP Security: Architecture-authentication Header- Encapsulating Security payload- Combining Security associations- Key management. Web Security: Web Security considerations- secure Socket Layer and Transport layer Security- Secure electronic transaction. Firewalls-Packet filters- Application Level Gateway- Encrypted tunnels.	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U42D	SOFT COMPUTING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course enables the learners to understand the concepts of Soft Computing techniques and its applications. It covers Artificial Neural Networks, operations and models of fuzzy logic, genetic algorithms and multi objective optimization techniques. This course helps the students to develop algorithms and solutions for different real world applications.

iii. **COURSE OUTCOMES**

CO1	Describe soft computing techniques and the basic models of Artificial Neural Network	Understand
CO2	Solve practical problems using neural networks	Apply
CO3	Illustrate the operations, model and applications of fuzzy logic	Apply
CO4	Illustrate the concepts of Genetic Algorithm	Apply
CO5	Describe the concepts of multi-objective optimization models and the need for using hybrid soft computing approaches	Understand

iv. **SYLLABUS**

Introduction to Soft Computing & Artificial Neural Network, Supervised Learning Network:. Back propagation Network – Architecture, Training and testing algorithm.
Fuzzy Logic & Defuzzification: Fuzzy membership functions, Methods of membership value assignments , Fuzzy relations–Fuzzy Propositions. Fuzzy implications. Defuzzification– Lamda cuts, Defuzzification methods.
Fuzzy Inference System & Genetic Algorithm, Operators in genetic algorithm . Multi Objective Optimization & Hybrid Systems, Dominance and pareto-optimality. Optimality conditions. Neuro-fuzzy hybrid systems. Genetic – neuro hybrid systems.

v. **(a) TEXT BOOKS**

1. S.N.Sivanandam and S.N. Deepa, Principles of Soft Computing , 2nd Edition, John Wiley & Sons.
2. Kalyanmoy Deb, Multi-objective Optimization using Evolutionary Algorithms, 1st Edition, John Wiley & Sons.

(b) OTHER REFERENCES

1. Timothy J Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2016.

2. T.S.Rajasekaran, G.A.Vijaylakshmi Pai "Neural Networks, Fuzzy Logic & Genetic Algorithms Synthesis and Applications", Prentice-Hall India.
3. Simon Haykin, "Neural Networks- A Comprehensive Foundation", 2/e, Pearson Education.
4. Zimmermann H. J, "Fuzzy Set Theory & Its Applications", Allied Publishers Ltd.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Introduction to Soft Computing & Artificial Neural Network** Introduction to Soft Computing, Difference between Hard Computing & Soft Computing & Applications of Soft Computing, Artificial Neurons Vs Biological Neurons, Basic models of artificial neural networks, Activation Functions McCulloch and Pitts Neuron, Hebb network	7
II	**Supervised Learning Network** Perceptron networks – Learning rule, Training and testing algorithm, Perceptron networks – Problems, Adaptive Linear Neuron, Adaptive Linear Neuron, Adaptive Linear Neuron-Problems, Back propagation Network, Back propagation Network	10
III	**Fuzzy Logic & Defuzzification** Introduction to Fuzzy Set, Properties & operations on fuzzy sets Fuzzy membership functions, Fuzzification, Methods of membership value assignments, Fuzzy relations, Operations on Fuzzy Relation, Fuzzy Propositions & Fuzzy Implications Lamda cuts for fuzzy sets, Defuzzification methods, Defuzzification methods	10
IV	**Fuzzy Inference System & Genetic Algorithm** Fuzzy Inference Systems - Mamdani type, Fuzzy Inference Systems - Sugeno type, Fuzzy Logic Controller, Introduction to genetic algorithm, operators in genetic algorithm - coding Selection, Cross over, Mutation, stopping condition for genetic algorithm	9
V	**Multi-Objective Optimization & Hybrid System** MOOP-Linear &Non linear, Convex & Non Convex, Principles of MOO-Illustrating Pareto Optimal Solutions, Objectives in MOO, Dominance & Pareto-Optimality-Concept of Domination ,Properties of Dominance Relation, Pareto Optimality, Procedure for finding a non dominated set ,Optimality Conditions, Neuro Fuzzy hybrid system-Classification& characteristics, Genetic – neuro hybrid systems	9
	Total hours	**45**

vii. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

viii. **Mark Distribution**

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U42E	FUZZY SET THEORY AND APPLICATIONS	PEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

This course equips the students to understand the concepts of fuzziness and its use in building better solutions to problems. The course covers basic concepts of fuzzy sets, fuzzy relations, fuzzy logic and building of fuzzy approximation-based solutions. It helps students to design and develop fuzzy based solutions to real world applications.

iii. COURSE OUTCOMES

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

CO1	Explain fuzzy logic based problem solving	Understand
CO2	Summarize the concepts of crisp sets, crisp relations, crisp logic with fuzzy sets, fuzzy relations and fuzzy logic.	Apply
CO3	Develop fuzzy systems by selecting appropriate membership functions, fuzzification and defuzzification methods	Apply
CO4	Develop solutions using graphical and rule-based methods	Apply
CO5	Make use of fuzzy logic inference to solve real world problems	Apply

iv. SYLLABUS

Basic Fuzzy Set Theory:The case for imprecision, Utility and Limitations of Fuzzy Systems, Fuzzy Sets and Membership, Classical Sets – Properties, Operations, Fuzzy Sets – Properties and Operations, Classical Relations – Cartesian Product, Operations and Properties of Crisp Relations, Composition, Fuzzy Relations – Cardinality, Operations, Properties, Fuzzy Cartesian Product and Composition.

Fuzzy Membership Functions: Tolerance and Equivalence Relations – Crisp and Fuzzy, Similarity Methods – Cosine, Min-max, Fuzzy Membership Functions – Features, Fuzzification, Defuzzification to Crisp Sets, λ-Cutsfor Fuzzy Relations, Linguistic Hedges.

Fuzzification and Defuzzification Methods: Development of Membership Functions –Intuition, Inference, Rank ordering, Inductive reasoning. Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima.

Fuzzy Inference:Classical Logic, Fuzzy Logic, Approximate Reasoning, Fuzzy (Rule-Based) Systems - Multiple conjunctive antecedents, Multiple disjunctive antecedents, Aggregation of fuzzy rules, Graphical Techniques of Inference.

Fuzzy Applications:Applications of Fuzzy Systems - Fuzzy Classification, Fuzzy Pattern Recognition, Fuzzy Control Systems, Fuzzy Systems and Neural Networks, Fuzzy Clustering, Fuzzy Databases and

Information retrieval systems.

v.(a) TEXT BOOKS

1. Fuzzy Logic with Engineering Applications – Timothy J. Ross, Third Edition, John Wiley and Sons, 2010
2. Fuzzy Sets and Fuzzy Logic: Theory and Applications - George J. Klir and Bo Yuan , Prentice Hall, 1995.

(b) OTHER REFERENCES

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and GraphTheory, Seventh Edition, MGH,2011
2. Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", TataMc Graw Hill Pub. Co. Ltd., New Delhi,2003.
3. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, "Discrete Mathematical Structures", Pearson Education Pvt Ltd., New Delhi,2003
4. Kenneth H .Rosen, "Discrete Mathematics and its Applications", 5/e, TataMc Graw Hill Pub. Co. Ltd, New Delhi2003

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Basic Fuzzy Set Theory** Introduction to Fuzzy Concepts – Case for imprecision- utility and limitations of Fuzzy Systems, Classical Sets – Properties, Operations, Fuzzy Sets – Properties, Operations, Classical Relations–Properties Operations –Cartesian Product, Composition, Fuzzy Relations – Properties, Operations, Cardinality, Fuzzy Cartesian Product, Fuzzy Composition	8
II	**Fuzzy Membership Functions** Tolerance and Equivalence Relations – Crisp, Tolerance and Equivalence Relations – Fuzzy, Similarity Methods – Cosine, Minmax, Fuzzy Membership Functions- Features, Fuzzification, Defuzzification to crisp sets – λ-cuts, Linguistic Hedges	9
III	**Fuzzification and Defuzzification Methods** Development of Membership Functions – Intuition, Inference, Development of Membership Functions – Rank Ordering, Development of Membership Functions – Inductive reasoning, Defuzzification – Max membership principle, weighted average method, mean max membership, Defuzzification – Centroid method, Defuzzification – Center of Sums, Center of Largest area, First/Last of maxima, Defuzzification – exercises	10
IV	**Fuzzy Inference** Classical Logic-Propositional Logic, Classical Logic-Predicate Logic, Fuzzy Logic,	9

	Fuzzy Approximation based reasoning, Fuzzy Rule based systems, Multiple conjuctive and disjunctive antecedents, aggregation, Graphical Techniques for Interference, Illustration of Graphical Techniques for Inference, Fuzzy Inference-Exercises	
V	**Fuzzy Applications** Fuzzy Control Systems, Illustration of Fuzzy Control Systems, Fuzzy Classification, Fuzzy Pattern Recognition, Fuzzy Systems and Neural Networks, Fuzzy Clustering, Fuzzy Databases, Fuzzy Information Retrieval Systems	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U42F	EMBEDDED SYSTEMS	PEC	2	1	0	3	2020

i. **PRE-REQUISITE :** CS1U20F Operating Systems , CS1U20D Computer Organization and Architecture

ii. **COURSE OVERVIEW**

The objective of this course is to familiarize learners with the technologies behind embedded computing systems. This course introduces and explains the role of different hardware, software, and firmware components involved in the design and development of embedded systems. It discusses how real time operating systems incorporate specific features to ensure timeliness of critical tasks. The course also aims to provide insights about the design followed in several real-world embedded devices and expose the recent trends in embedded system design to the students.

iii. **COURSE OUTCOMES**

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

CO1	Describe the characteristics of different hardware/software components of an embedded system.	Understand
CO2	Map the design of an embedded system to an appropriate computational model.	Understand
CO3	Recommend appropriate process synchronization / communication / scheduling mechanisms for specific system scenarios.	Analyze
CO4	Describe the role of real-time operating systems in embedded devices.	Understand
CO5	Make use of design strategies for developing real-world embedded systems.	Apply

iv. **SYLLABUS**

Introduction to Embedded Systems: Embedded Systems – Definitions, Embedded Systems vs. General Computing Systems, History, Classification, Application Areas, Purpose. Sensors and Actuators, I/O Subsystem Interface, Communication Interface, Embedded Firmware, Embedded System Design Process

System Modeling and Hardware Software Co-Design: Computational Models in Embedded Design – Embedded Development Cycle, History, Advantages of the Co-Design Methodology, The Co-Design Process, Fundamental Issues in Hardware Software Co-Design. Hardware software trade-offs.

Real-Time Embedded System Design: Operating System – Basics, Types. Basics of Tasks, Process and Threads. Multiprocessing and Multitasking. Task Scheduling Task Synchronization – Synchronization Issues ,Embedded Design – Functional and Non-Functional Requirements.

Embedded Firmware Design and Development, and EDLC: Embedded Firmware Design and Development ,Embedded Product Development Life Cycle – Objectives, Different Phases, Modeling Techniques

Embedded System Industry – Case Studies and Applications: Design Case Studies – Battery Operated Smart Card Reader, Automated Meter Reading System, Smart Watch.

Automotive and Aerospace Systems – Networked Control Systems in Cars and Airplanes, Internet of Things Systems – IoT System Architectures - Use Cases

v.(a) TEXT BOOKS

1. K. V. Shibu, *Introduction to Embedded Systems*, McGraw Hill Education, Second Edition, 2017.
2. James K. Peckol, *Embedded Systems: A Contemporary Design Tool,* John Wiley & Sons, Second Edition, 2019.
3. Marilyn Wolf, *Computers as Components-Principles of Embedded Computing System Design,* Morgan Kaufmann, Elsevier, Fourth Edition, 2016.

(b) OTHER REFERENCES

1. Jorgen Staunstrup and Wayne Wolf, *Hardware/Software Co-Design: Principles and Practice,* Springer Science & Business Media, 2013.
2. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*. Tata McGraw-Hill Education, 2011.
3. Daniel D. Gajski, Samar Abdi, Andreas Gerstlauer, and Gunar Schirner, *Embedded System Design: Modeling, Synthesis and Verification,* Springer Science & Business Media, 2009.
4. Peter Marwedel, *Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things,* Springer, 2017.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Introduction to Embedded Systems** Introduction–Embedded Systems, Characteristics and Quality Attributes of Embedded Systems, System Core (Microprocessors, Microcontrollers, DSP, ASICs, PLDs), System Core (Microprocessors, Microcontrollers, DSP, ASICs, PLDs),Memory (Different ROMs and RAMs), Sensors and Actuators, I/O Subsystem Interface ,Communication Interface, Embedded Firmware, Other System Components (Reset and Brown-out Protection Circuits, Oscillator Unit, Real-Time Clock, Watchdog Timer), Printed Circuit Board, Embedded System Design Process– Requirements, Specification, Architecture Design, Embedded System Design Process–Designing Hardware and Software Components, System Integration.	8

II	**System Modeling and Hardware Software Co-Design** Computational Models in Embedded Design – Data Flow Graph,Control Data Flow Graph , Computational Models in Embedded Design – State Machine Model, Sequential Program Model, Computational Models in Embedded Design – Concurrent Process Model, Object-Oriented Model. , Hardware Software Co- Design – Traditional Embedded Development Cycle, History, Advantages of the Co-Design Methodology , The Co-Design Process , Fundamental Issues in Hardware Software Co-Design. Hardware software trade-offs.	9
III	**Real-Time Embedded System Design** Task Communication–Shared Memory, Message Passing, Task Communication–Remote Procedure Call and Sockets, Task Synchronization–Synchronization Issues – Race Condition, Deadlock, Task Synchronization–Synchronization Issues – Priority Inversion, Priority Inheritance, Priority Ceiling, Synchronization Techniques – Spin Lock, Sleep & Wakeup, Semaphores, Synchronization Techniques – Spin Lock, Sleep & Wakeup, Semaphores, Selection of an RTOS for an Embedded Design – Functional and Non Functional Requirements	10
IV	**Embedded Firmware Design and Development, and EDLC** Firmware Design Approaches, Firmware Development Languages, Firmware Development Languages, Integration of Embedded Hardware and Firmware, Embedded Product Development Life Cycle–Objectives, Different Phases, Embedded Product Development Life Cycle – Modeling Techniques – Waterfall Model, Incremental Model, Evolutionary Model, Spiral Model (Review Only)	9
V	**Embedded System Industry – Case Studies and Applications** Design Case Studies–Battery Operated Smart Card Reader, Design Case Studies–Automated Meter Reading System, Design Case Studies–Smart Watch, Automotive and Aerospace Systems – Networked Control Systems in Cars and Airplanes, Automotive and Aerospace Systems – Vehicular Networks –CAN bus, Time-triggered Architecture, FlexRay and LIN, Internetof Things Systems – IoT System Architectures – Use Cases (Smart Appliance, Monitoring and Control Systems), Internet of Things Systems – Networks for IoT – Networking concepts, Bluetooth, Bluetooth Low Energy, 802.15.4, ZigBee and WiFi., Internet of Things Systems – Databases and Time wheels, Smart Home Example	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of SeriesTests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U42G	COMPUTER VISION	PEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs. The curriculum covers the basics of image formation, key computer vision concepts, methods, techniques, pattern recognition, various problems in designing computer vision and object recognition systems. This course enables the learners to understand the fundamentals of computer vision and develop applications in computer vision.

iii. COURSE OUTCOMES

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

CO1	Summarize basic concepts, terminology, theories, models and methods in the field of computer vision.	Understand
CO2	Explain basic methods of computer vision related to multi-scale representation, edge detection, detection of other primitives, stereo, motion and object recognition.	Understand
CO3	Describe principles of Segmentation, Motion Segmentation and Classification.	Understand
CO4	Select appropriate object Tracking and detection methods for computer vision applications	Understand
CO5	Implement a computer vision system for a specific problem	Apply

iv. SYLLABUS

Image Formation and Filtering: Geometric Camera Models. Linear Filters. Filters as Templates.
Local Image Features and Stereo Vision: Image Gradients. Stereopsis.
Segmentation: Segmentation by clustering. Motion Segmentation by Parameter Estimation.

Classification and Tracking: Classification.Tracking.

Finding Objects and other Applications: Object detection. Applications - Robot Navigation by stereo vision, Face detection, Face recognition, Activity Recognition, Tracking people.

v. (a) TEXT BOOKS

1. David, and Jean Ponce. Computer vision: A modern approach. Prentice hall, 2011.

(b) OTHER REFERENCES

1. Szeliski, Richard, Computer vision: algorithms and applications. Springer Science & Business Media, 2010.

2. Medioni, Gerard, Emerging topics in computer vision. and Sing Bing Kang. Prentice Hall PTR, 2004.

3. Trucco, Emanuele, and Alessandro Verri, Introductory techniques for 3-D computer vision. Vol. 201. Englewood Cliffs: Prentice Hall, 1998.

4. Faugeras, Olivier, and Olivier Autor Faugeras, Three-dimensional computer vision: a geometric viewpoint. MIT press, 1993.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	Geometric Camera model - Pinhole perspective, Geometric Camera model - Intrinsic Parameters, Geometric Camera model - Extrinsic Parameters, Geometric Camera Calibration – Linear Approach, Linear Filters and Convolution, Shift Invariant Linear Systems - Discrete convolution, Normalized Correlation and Finding patterns	7
II	Local Image Features - Computing the Image Gradient, Gradient Based Edge Detection, Gradient Based Corner Detection, Stereopsis - Binocular Camera Geometry and Epipolar Constraint, Essential Matrix and Fundamental Matrix, Binocular Reconstruction, Local Methods for Binocular Fusion, Global Methods for Binocular Fusion	9
III	Segmentation basics, Applications - Background Subtraction, Interactive Segmentation, Forming Image Regions, Segmentation by clustering - The Watershed Algorithm, Motion Segmentation by Parameter Estimation - Optical Flow and Motion, Flow Models and Motion Segmentation with Layers	10
IV	Classification Basics, Two-class and Multiclass classifier, Error, Overfitting and Regularization, Cross Validation, Classifying Images of Single Objects Tracking Basics, Simple Tracking Strategies, Tracking by detection, Linear Dynamical models, The Kalman Filter background, Kalman filter algorithm	10
V	Detecting Objects in Images- The Sliding Window Method, Object Recognition - Goals of Object Recognition System, Application of binocular stereo vision - Robot Navigation, Face detection, Face recognition, Activity recognition, Tracking people	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2)	: 25 marks
Continuous Assessment Assignment	: 15 marks
Total Marks	**: 50 marks**

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

PROGRAM ELECTIVE IV

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U43A	FORMAL METHODS AND TOOLS IN SOFTWARE ENGINEERING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The course enables the learners to apply formal methods for modelling, validation and verification of software systems. It covers a series of advanced tools that address challenges faced in design, coding and verification. This includes both an introduction to the theoretical underpinnings of these tools, as well as hands-on exploration.

iii. **COURSE OUTCOMES**

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

CO1	Explain the need and use of formal methods and tools in software engineering.	Understand
CO2	Demonstrate conceptual modelling of systems using Alloy.	Apply
CO3	Illustrate the process of proving correctness of code using Hoare-Triple based weakest precondition analysis.	Apply
CO4	Demonstrate program verification using VCC.	Apply

iv. **SYLLABUS**

Introduction to formal methods and tools in software engineering, software defects and causes, dealing with software defects, Testing and verification. Ensuring reliability in design phase, conceptual modelling , alloy models, verification by model checking, program verification, inter procedure verification ofprograms in VCC, Ghost language and ownership in VCC.

v. **(a) TEXT BOOKS**

1. Daniel Jackson, Software Abstractions, MIT Press, 2011.

(b) OTHER REFERENCES

1. Tutorial for Alloy Analyzer 4.0
2. E. Cohen, M. A., Hillebrand, S. Tobies, M. Moskal, W. Schulte, Verifying C Programs: A VCC Tutorial, Working draft, version 0.2, July 10, 2015
3. The VCC Manual, Working draft, version 0.2, April 7, 2016.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction** Stages in software development, Software defects and causes of software defects, Techniques for dealing with software defects, Testing and verification, Formal methods and formal verification	7
II	**Conceptual Modelling in Alloy** Introduction to Conceptual modelling, Overview of Alloy, Architecture of alloy, Conceptual modelling in Alloy, Analysing Alloy models, Fixing bugs in modelling, How Alloy works?, Show that the Konigsberg Bridge Problem has no solution	9
III	**Hoare Logic and Introduction to VCC** Introduction to VCC, Verifying C programs in VCC- Assertions, Logical Operators and Quantifiers, Assumptions, Overflows and unchecked arithmetic, Hoare Logic -Simple Imperative Programming Language, Partial Correctness Specification, Meaning of Hoare Triples, Hoare-Triple-based tool for Verifying Concurrent C, Partial vs Total Correctness, Proving Partial Correctness, Inference Rules for the Simple Imperative Programming Language, Inference Rules for the Simple Imperative Programming Language, Weakest Precondition, Invariant vs. Inductive Invariant, Intra-procedure verification of programs, Verification of Hoare Triples	10
IV	**Program Verification** Inter-procedure verification of programs in VCC, Function contracts, Pure functions, Quantifiers, loop-invariants and Object invariant, Triggers in VCC, Proving total correctness of programs in VCC	9
V	**Ghost Language and Ownership in VCC** Ghost Language of VCC, Modelling programs in the ghost language, Verification of a C program with respect to a ghost model, Ownerships in VCC, Phrasing refinement conditions in VCC, Proving refinements in VCC, Example problems, Proving refinements in VCC, Example problems	10
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U43B	CLIENT SERVER ARCHITECTURE	PEC	2	1	0	3	2020

i. PRE-REQUISITE : CS1U30B Computer Networks

ii. COURSE OVERVIEW

The syllabus is prepared with the view of preparing the Engineering Graduates to build effective Client/Server applications. This course aims at providing a foundation in decentralized computer systems, using the client/server model. The course content is decided to cover the essential fundamentals which can be taught within the given slots in the curriculum.

iii. COURSE OUTCOMES

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

CO 1	Explain the basics of client/server systems and the driving force behind the development of client/server systems	Understand
CO 2	Outline the architecture and classifications of client/server systems	Understand
CO 3	Choose the appropriate client/server network services for a typical application	Understand
CO 4	Describe management services and issues in network	Understand
CO 5	Compare and summarize the web extensions and choose appropriate web services standards for an application	Understand

iv. SYLLABUS

Introduction: Introduction to Client/Server computing - Development of client/server systems, Client/Server security, Organizational Expectations, Improving performance of client/server applications,Applications of Client/Server.

Client/Server Application Components: Classification of Client/Server Systems- Two-Tier Computing, Middleware, Three-Tier Computing- Model View Controller (MVC), Existing Client/Server Architecture. Architecture for Business Information System.

Client/Server Network: Client- Services, Request for services, RPC, Dynamic Data Exchange (DDE). Object Linking and Embedding (OLE). Common Object Request Broker Architecture (CORBA).Server- Detailed server functionality

Client/ Server Systems Development: Services and Support- System administration, Availability, Reliability, Scalability, Observability, Agility, Serviceability. Software Distribution, Performance, Network management. Remote Systems Management

Client/Server Technology and Web Services: Web Services History. Web Server Technology- Web

Server, Role of Java for Client/Server on Web. Web Services,Client/Server/Browser

v. (a) TEXT BOOKS

1. Patrick Smith & Steave Guengerich, “Client / Server Computing”, PHI
2. Dawna Travis Dewire, “Client/Server Computing”, TMH

v. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction** Driving forces behind Client/ Server, Client Server development tools, Development of client/server systems, Client/Server security, Organizational Expectations, Improving performance of client/server applications, Single system image, Downsizing and Rightsizing, Advantages and Applications of client server computing	8
II	**Client/Server Application Components** Classification of Client/Server Systems, Open System Standards, Two-Tier Computing, Three-Tier Computing, Middleware, Principles behind Client/Server Systems, Client/Server Topologies, Existing Client/Server Architecture, Architecture for Business Information System.	9
III	**Client/Server Network** The client: Services, Request for services, RPC, Windows services, Print services, Remote boot services, Utility Services & Other Services, Dynamic Data Exchange (DDE), Object Linking and Embedding (OLE), Common Object Request Broker Architecture (CORBA), The server: Detailed server functionality, the network operating system, Available platforms, the server operating system	9
IV	**Client Server Systems Development** Services and Support, System administration, Availability, Reliability, Scalability, Observability, Agility Serviceability, Software Distribution, Performance, Network management, Remote Systems Management, RDP,Telnet,SSH, Security ,LAN and Network Management issues, Training, Connectivity, Communication interface technology, Interposes communication, wide area network technologies, Network Acquisition, PC- level processing unit, x-terminals, server Hardware	9

V	**Client/Server Technology And Web Services** Web Services History , Web Server Technology , Web Server, Web Server Communication , Role of Java for Client/Server on Web, Web Services , MicroServices, APIs, API Gateway, Authentication of users/clients, Tokens/Keys for Authentication ,Service Mesh, Message Queues, SaaS, Web Sockets ,Client/Server Technology and Web Applications, Balanced Computing and the Server's Changing Role ,Thin client computing , Computing models, Computing Environment, Future of client/ server Computing Enabling Technologies, Transformational system	10
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U43C	PARALLEL COMPUTING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** CS1U20D Computer Organization and Architecture.

ii. **COURSE OVERVIEW**

This course helps the learners to understand basic and advanced concepts of parallel computing. It covers Principles of Parallel Algorithm Design, Communication operations, Programming Using the Message Passing Paradigm, Programming Shared Address Space Platforms Thread Basics, and GPU Programming. This course enables a learner to design solutions to complex real world problems using parallel computing paradigms including thread parallelism, shared memory program, message passing interfaces, and vector processing.

iii. **COURSE OUTCOMES**

CO1	Summarize the key parallel computational models	Understand
CO2	Appreciate and apply parallel and distributed algorithms in problem Solving	Apply
CO3	Appreciate the communication models for parallel algorithm development	Understand
CO4	Develop parallel algorithms using message passing paradigm	Apply
CO5	Formulate parallel algorithms for shared memory architectures.	Apply
CO6	Demonstrate the fundamental skills of heterogeneous computing with GPUs	Apply

iv. **SYLLABUS**

Principles of Parallel Algorithm Design, Decomposition Techniques, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models. Communication Operations, Programming Using the Message Passing Paradigm, MPI,
Thread Basics, OpenMP, GPU Programming: Heterogeneous Parallel Computing, Architecture of a Modern GPU, Data parallel computing, CUDA C Program Structure, A Vector Addition Kernel, CUDA Thread Organization, Importance of Memory Access Efficiency, Cuda Memory Types.

v. **(a)TEXT BOOKS**

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, 2nd Ed, Addison-Wesley, 2003
2. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed., Morgan Kaufman, 2016.

(b) OTHER REFERENCES

1. Steven Brawer, Introduction to Parallel Computing, Academic Press, (1989)
2. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Paralwlel Programming, MIT Press, 2008.
3. William Gropp, Ewing Lusk, Anthony Skjellum Using MPI: Portable Parallel Programming with the Message-Passing Interface, 3rd Ed, MIT Press, 2014.
4. Thomas Rauber, Gudula Rünger, Parallel Programming for Multicore and Cluster Systems, Springer, 2010

vi. **COURSE PLAN**

Module	Contents	No. of Hours
I	**Basic Introduction to Parallel Processing** Basic Introduction to Parallel Processing platforms. Preliminaries, Decomposition Techniques – Recursive, Data, Decomposition Techniques – Exploratory, Speculative, Hybrid, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing –Static, Mapping Techniques for Load Balancing – Dynamic, Methods for Containing Interaction Overheads, Parallel Algorithm Models.	7
II	**Basic Communication Operations** One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scallter Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operation	8
III	**Programming Using the Message Passing Paradigm** Principles of Message-Passing Programming, The Building Blocks: Send and Receive Operations, MPI: The Message Passing Interface, MPI: The Message Passing Interface : Illustration, Overlapping Communication with Computation, Overlapping Communication with Computation : Illustration, Collective Communication and Computation Operations, Collective Communication and Computation Operations : Illustration	10
IV	**Programming Shared Address Space Platforms** Thread Basics, Why Threads? The POSIX Thread API, Synchronization Primitives in POSIX, Controlling Thread and Synchronization Attributes, Thread Cancellation, Composite Synchronization Constructs, OpenMP: a Standard for Directive Based Parallel Programming, Specifying Concurrent Tasks in OpenMP, Synchronization Constructs in OpenMP, Data Handling in OpenMP, OpenMP Library Functions, OpenMP Applications: Parallel algorithm development for Matrix multiplication	10

V	**GPU Programming** Heterogeneous Parallel Computing, Architecture of a Modern GPU, Speeding up Real Applications, Data parallel computing – CUDA C Program Structure, Vector Addition Kernel, Device Global Memory and Data Transfer, Kernel Functions and Threading, Kernel Launch, CUDA Thread Organization, Mapping Threads to Multidimensional Data, Synchronization and Transparent Scalability, Resource Assignment, Querying Device Properties, Thread Scheduling and Latency Tolerance, Importance of Memory Access Efficiency, Cuda Memory Types, Tiling for Reduced Memory Traffic, Tiled Matrix Multiplication Kernel, Boundary Checks	10
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U43D	DATA COMPRESSION TECHNIQUES	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course helps the learners to understand compression techniques on text, image, audio and video data. It covers lossy &lossless compression, RLE, JPEG, MPEG and its variants. This course enables the students to develop and implement compression algorithms on different domains.

iii. **COURSE OUTCOMES**

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

CO1	Describe the fundamental principles of data compression.	Understand
CO2	Make use of statistical and dictionary based compression techniques for various applications	Apply
CO3	Illustrate various image compression standards.	Apply
CO4	Summarize video compression mechanisms to reduce the redundancy in video.	Understand
CO5	Use the fundamental properties of digital audio to compress audio data.	Understand

iv. **SYLLABUS**

Modelling and types of compression: Introduction to Compression Techniques, Mathematical modelling for Lossless and lossy compression, Basic Compression Methods: Basic Compression Technique, Statistical Methods, Text & Image Compression: Dictionary based Coding, Image Compression, Video Compression- Analog video, Digital Video, Motion Compensation, MPEG standards, Audio Compression-
Basics of Digital Audio, Basic Audio Compression Techniques, MPEG Audio Compression

v. **(a) TEXT BOOKS**

1. David Solomon, Data compression: the complete reference, 4/e, Springer, January 2007
2. Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers,2003.

(b) OTHER REFERENCES

1) Stephen Welstead, Fractal and wavelet Image Compression techniques, PHI, 1999.
2) Sleinreitz, Multimedia System, Addison Wesley.
3) Mark Nelson and Jean-loup Gailly, The Data Compression Book, M&T Books.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Modelling and types of compression** Introduction to Compression Techniques- Lossy compression & Lossless compression, Measures of Performance, Modelling and coding, Physical model for lossless compression, Physical model for lossy compression, Probability model for lossless compression, Probability model for lossly compression	8
II	**Basic Compression Methods** Run length encoding, RLE Text compression, Statistical methods-Prefix Codes, Binary Huffman coding, Illustration of Binary Huffman coding, Non-binary Huffman Algorithms, Arithmetic Coding algorithm, Illustration of Arithmetic Coding algorithm,	11
III	**Text & Image Compression** LZ77 compression, LZ78 Compression, LZW Compression, Basics of Image compression and Image standards, Baseline JPEG Image compression, JPEG-LS Image compression	9
IV	**Video Compression** Basics of Video Compression- Analog video and Digital Video, Motion Compensation, MPEG-1 standard and Video Syntax, MPEG-1 Pel Reconstruction, MPEG-4 standard, Functionalities for MPEG-4	9
V	**Audio Compression** Basics of Audio Compression, Digital Audio, Basic Audio Compression Techniques, MPEG Audio Compression basics- Frequency Domain Coding, Encoding: Layers I and II, Encoding: Layer II -Psychoacoustic Models, Psychoacoustic Models - Encoding: Layer III	8
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U43F	DATA MINING	PEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

This course helps the learner to understand the concepts of data mining and data warehousing. It covers the key processes of data mining, data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, web mining and text mining. It enables the learners to develop new data mining algorithms and apply the existing algorithms in real-world scenarios.

iii. COURSE OUTCOMES

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

CO1	Employ the key process of data mining and data warehousing concepts in application domains.	Understand
CO2	Make use of appropriate preprocessing techniques to convert raw data into suitable format for practical data mining tasks	Apply
CO3	Illustrate the use of classification and clustering algorithms in various application domains	Apply
CO4	Comprehend the use of association rule mining techniques.	Apply
CO5	Explain advanced data mining concepts and their applications in emerging domains	Understand

iv. SYLLABUS

Introduction to Data Mining and Data Warehousing, Data Preprocessing: Data Reduction-Data cube aggregation, Attribute subset selection, Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation. Advanced classification and Cluster analysis: Classification-Introduction, Decision tree construction principle, Splitting indices ,Classification Accuracy-Precision, Recall. Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK. Association Rule Analysis: Apriori(Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm Web Mining. Text Mining

v. (a) TEXT BOOKS

1. Dunham M H, “Data Mining: Introductory and Advanced Topics”, Pearson Education, New Delhi, 2003.

2. Arun K Pujari, "Data Mining Techniques", Universities Press Private Limited,2008.
3. Jaiwei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, 2006

(b) OTHER REFERENCES

1. M Sudeep Elayidom, "Data Mining and Warehousing", 1st Edition, 2015, Cengage Learning India Pvt. Ltd.
2. Mehmed Kantardzic, "Data Mining Concepts, Methods and Algorithms", John Wiley andSons, USA, 2003.
3. Pang-Ning Tan and Michael Steinbach, "Introduction to Data Mining", Addison Wesley, 2006.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction to Data Mining and Data Warehousing** Data warehouse-Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture, Data Warehousing to Data Mining, Datamining Concepts and Applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities, Data Mining Functionalities, Data Mining Issues	8
II	**Data Preprocessing** Data Preprocessing: Need of Data Preprocessing, Data Cleaning- Missing values, Noisy data, Data integration, Data transformation, Data Reduction-Data cube aggregation, Attribute subset selection, Data Reduction-Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation	8
III	**Advanced classification and Cluster analysis** Classification- Introduction, Decision tree construction principle, Splitting indices-Information Gain, Gini index, Decision Tree- ID3, Decision Tree- ID3, Decision tree construction with presorting- SLIQ, Accuracy and error measures, evaluation, Introduction to clustering, Clustering Paradigms, Partitioning Algorithm- PAM, Hierarchical Clustering-DBSCAN, Categorical Clustering-ROCK	10
IV	**Association Rule Analysis** Association Rules: Introduction, Methods to discover association rules, A priori algorithm (Level-wise algorithm), Partition Algorithm, Pincer Search Algorithm, Pincer Search Algorithm, Dynamic Itemset Counting Algorithm, FP-tree Growth Algorithm	10
V	**Advanced Data Mining Techniques** Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Web Structure Mining –Clever algorithm, Web Usage Mining- Preprocessing, Data structures, Web Usage Mining -Pattern Discovery, Pattern Analysis, Text Mining-Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Techniques Query Processing Techniques	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U43G	MOBILE COMPUTING	PEC	2	1	0	3	2020

i. PRE-REQUISITE: Nil

ii. COURSE OVERVIEW

The course is designed with the view of preparing the engineering students capable of understanding the communication protocols, various architectures and security features used in mobile computing. This course covers basics of mobile computing, architecture of wireless transmission systems and next generation networks. This course enables the learners to acquire advanced concepts on wireless communication systems and mobile ad-hoc networks.

iii. COURSE OUTCOMES

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

CO1	Explain the various mobile computing applications, services, design considerations and architectures	Understand
CO2	Describe the various technology trends for next generation cellular wireless networks and use the spreading concept on data transmission	Apply
CO3	Summarize the architecture of various wireless LAN technologies	Understand
CO4	Identify the functionalities of mobile network layer and transport layer	Understand
CO5	Explain the features of Wireless Application Protocol	Understand
CO6	Interpret the security issues in mobile computing and next generation technologies	Understand

iv. SYLLABUS

Mobile Computing Basics, Internet, Wireless Transmission and Communication Systems, Medium Access Control, Satellite Systems Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Routing, Localization, Handover. Telecommunication Systems ,Wireless LANs,Mobile Network and Transport Layer, Mobile Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR), Destination Sequence Distance Vector (DSDV), Ad-hoc routing protocols. Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP. Wireless Application Protocol (WAP) , Mobile Security and Next Generation Networks.

v.(a) TEXT BOOKS

1. Asoke K. Talukder, Hasan Ahmad, Roopa R Yavagal, Mobile Computing Technology-Application and Service Creation, 2/e, McGraw Hill Education.
2. Jochen Schiller, Mobile Communications, Pearson Education Asia, 2008.
3. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley Publishers, 2015.

(b) OTHER REFERENCES

1. Raj Kamal, Mobile Computing, 2/e, Oxford University Press.
2. Andrew S. Tanenbaum, Computer Networks, PHI, 3/e, 2003
3. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2/e, PHI, New Delhi, 2004.
4. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

vi.COURSE PLAN

Module	Contents	No. of Hours
I	**Mobile Computing Basics** Introduction to mobile computing – Functions, Middleware and Gateways, Application and services, Internet: The Ubiquitous network, Three-tier architecture for Mobile Computing, Design considerations for mobile computing	7
II	**Wireless Transmission and Communication Systems** Direct sequence spread spectrum, Frequency hopping spread spectrum, Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Satellite Systems Basics, Applications, Geostationary Earth Orbit (GEO), Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Routing, Localization, Handover, Global System for Mobile Communication (GSM) services, Architecture, Handover, Security	10
III	**Wireless LANs** Wireless LAN - Advantages, Design goals, Applications, Infrastructure Vs Ad-hoc mode, IEEE 802.11 System Architecture, Protocol Architecture, Physical layer, Medium Access Control layer, HIPERLAN-1, Bluetooth	9
IV	**Mobile Network and Transport Layer** Mobile Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP), Mobile ad-hoc networks – Routing, Dynamic Source Routing (DSR), Destination Sequence Distance Vector (DSDV), Ad-hoc routing protocols, Traditional Transmission Control Protocol (TCP), Improvements in Classical TCP, Wireless Application Protocol (WAP) – Architecture, Wireless Datagram Protocol (WDP), Wireless Application Protocol (WAP) – Architecture, Wireless Datagram Protocol (WDP), Wireless Transport Layer Security (WTLS), Wireless Transaction Protocol (WTP), Wireless Session Protocol (WSP)	10

V	**Mobile Security and Next Generation Networks** Information security, Security techniques, Security algorithms, Security models, Introduction to Next generation networks, Orthogonal Frequency Division Multiplexing (OFDM), Wireless Asynchronous Transfer Mode (WATM), Multi Protocol Label Switching (MPLS), 10 pillars of 5G, Security for 5G communication.	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

PROGRAM ELECTIVE V

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U44A	HIGH PERFORMANCE COMPUTING	PEC	2	1	0	3	2020

i. PRE-REQUISITE: CS1U20D Computer Organization and Architecture, CS1U30D Microprocessors and Microcontrollers and CS1U20F Operating Systems.

ii. COURSE OVERVIEW

This course helps the learners to understand the different architectural features of high-end processors. This course discusses the Basics of high-end processors Architecture, Instruction-Level Parallelism, Data-Level Parallelism, Thread Level Parallelism, and GPU Architectures. This course enables the students to provide solutions to real-world problems making use of the capabilities of HPC systems.

iii. COURSE OUTCOMES

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

CO1	Describe different types of modern processing environments and parallel computing hardware .	Understand
CO2	Summarize the concepts of Instruction Level Parallelism .	Understand
CO3	Appreciate the idea of Data Level Parallelism.	Apply
CO4	Demonstrate the concept of Thread Level Parallelism.	Apply
CO5	Describe the basics of GPU architecture.	Understand

iv. SYLLABUS

Basics of Architecture : Classes of Parallelism and Parallel Architectures, Quantitative Principles of Computer Design, Virtual Memory and Virtual Machines ,Instruction-Level Parallelism: Concepts and Challenges, Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput, Data-Level Parallelism: Vector Architecture, Graphics Processing Units
Thread Level Parallelism: Multiprocessor Architecture, Distributed Shared-Memory and Directory-Based Coherence – Synchronization, Introduction to Memory Consistency
GPU Architectures: The CPU, The PCI bus, Multi-GPU platforms.

v.(a) TEXT BOOKS

1. John L. Hennessy, David A. Patterson Computer Architecture, Sixth Edition A Quantitative Approach, Morgan Kaufman, Fifth Edition, 2012.
2. Robert Robey, Yuliana Zamora, Parallel and High-Performance Computing, Manning Publications, First Edition, 2021.

(b) OTHER REFERENCES

1. Thomas Sterling, Matthew Anderson, and MaciejBrodowicz, High-Performance Computing – Modern Systems and Practices, First Edition, 2017.
2. Charles Severance, Kevin Dowd,High-Performance Computing, O'Reilly Media, Second Edition, 1998.
3. Kai Hwang, Faye Alaye Briggs, Computer Architecture and Parallel Processing, McGraw-Hill, 1984.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Basics of Architecture** Classes of Computers, Classes of Computers, Classes of Parallelism and Parallel Architectures, Dependability, Quantitative Principles of Computer Design, Basics of Memory Hierarchies, Virtual Memory and Virtual Machines, Pipelining	7
II	**Introduction to Syntax Analysis** Instruction-Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs With Advanced Branch Prediction, Hardware-Based Speculation, Multithreading, Exploiting Thread- Level Parallelism to Improve Uniprocessor Throughput, Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput.	11
III	**Data-Level Parallelism** Vector Architecture, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Detecting and Enhancing Loop-Level Parallelism	11
IV	**Thread Level Parallelism** Multiprocessor Architecture: Issues and Approach, Centralized Shared- Memory Architectures, Centralized Shared-Memory Architectures, Performance of Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory, Directory-Based Coherence, Synchronization,Introduction to Memory Consistency	9
V	**GPU Architectures** The CPU-GPU system as an accelerated computational platform, The GPU and the thread engine, The GPU and the thread engine, Characteristics of GPU memory spaces, PCI bus: CPU to GPU data transfer overhead, Multi-GPU platforms, Potential benefits of GPU-accelerated platforms	7
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U44B	BLOCKCHAIN TECHNOLOGIES	PEC	2	1	0	3	2020

i. PRE-REQUISITE: CS1U20A Data Structures and CS1U20F Operating Systems

ii. COURSE OVERVIEW

The purpose of this course is to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

iii. COURSE OUTCOMES

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

CO1	Illustrate the cryptographic building blocks of blockchain technology.	Understand
CO2	Explain the fundamental concepts of blockchain technology.	Understand
CO3	Summarize the classification of consensus algorithms.	Understand
CO4	Explain the concepts of first decentralized cryptocurrency bitcoin.	Understand
CO5	Explain the use of smart contracts and its use cases.	Understand
CO6	Develop simple applications using Solidity language on Ethereum platform.	Apply

iv. SYLLABUS

Fundamentals of Cryptography: Introduction to cryptography, Digital signature algorithms, Applications of cryptographic hash functions – Merkle trees, Distributed hash tables. Fundamentals of Blockchain Technology: Elements of blockchain. Consensus. Decentralization. Consensus Algorithms and Bitcoin: Consensus Algorithms, Bitcoin, Transactions, Blo
ckchain, Mining, Wallets. Smart Contracts and Use cases: Smart Contracts, Decentralization, Decentralized applications. Ethereum and Solidity: Ethereum – The Ethereum network, The Ethereum Virtual Machine. The Solidity language, Smart contracts Case study.

v. (a) TEXT BOOKS

1. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus

protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, Packt Publishing, Third edition, 2020.

(b) OTHER REFERENCES

2. Ritesh Modi, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain, Packt Publishing, First edition, 2018.
3. Kumar Saurabh, Ashutosh Saxena, Blockchain Technology: Concepts and Applications, First Edition, Wiley Publications, First edition, 2020.
4. Chandramouli Subramanian, Asha A George, et al, Blockchain Technology, Universities Press (India) Pvt. Ltd, First edition, August 2020.
5. Lorne Lantz, Daniel Cawrey, Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, O'Reilly Media, First edition, 2020.
6. Andreas M. Antonopoulos, Gavin Wood, Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, First edition, 2018.

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Fundamentals of Cryptography** Introduction to cryptography, Symmetric cryptography, AES, Asymmetric cryptography, RSA, Elliptic curve cryptography, Digital signatures – RSA digital signature algorithm, Secure Hash Algorithms – SHA-256, Applications of cryptographic hash functions – Merkle trees, Distributed hash tables,	9
II	**Fundamentals of Blockchain Technology** Blockchain – definition and architecture, Elements of blockchain, Blockchain – benefits and limitations, types, Consensus – definition, types, consensus in blockchain, Decentralization using blockchain, Methods of decentralization, Routes to decentralization, Blockchain and full ecosystem decentralization	8
III	**Consensus Algorithms and Bitcoin** Consensus Algorithms – Crash fault-tolerance (CFT) algorithms – Paxos, Raft (working is expected), Byzantine fault-tolerance (BFT) algorithms – Practical Byzantine Fault Tolerance (PBFT) (working is expected), Proof of work (PoW), Proof of stake (PoS), Types of PoS, Bitcoin – Definition, Cryptographic keys – Private keys, public keys, addresses, Transactions – Lifecycle, coinbase transactions, transaction validation, Blockchain – The genesis block. Mining – Tasks of miners, Mining – mining algorithm, hash rate. Wallets – Types of wallets	9
IV	**Smart Contracts and Use cases** Smart Contracts – Definition, Smart contract templates, Oracles, Types of oracles, Deploying smart contracts, Decentralization terminology – Decentralized applications, Decentralized Autonomous Organizations, Use cases of Blockchain technology – Government, Health care, Use cases of Blockchain technology – Finance, Supply chain management, Blockchain and Allied Technologies – Blockchain and Cloud Computing, Blockchain and Artificial Intelligence	8
V	**Ethereum and Solidity**	9

	Ethereum - The Ethereum network, Components of the Ethereum ecosystem – Keys and addresses, Accounts, Components of the Ethereum ecosystem – Transactions and messages, The Ethereum Virtual Machine, Ethereum Blocks and blockchain, The Soliditylanguage – The layout of a Solidity source code, Structure of a smart contract, variables, data types, The Solidity language – control structures, events, inheritance, libraries, The Solidity language – functions, error handling, Smart contracts Case study: Voting, Smart contracts Case study: Auction	
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U44C	IMAGE PROCESSING TECHNIQUE	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course helps the learners understand the core concepts and applications of Digital Image Processing. It covers Digital Image Fundamentals, Image Transforms, Image Enhancement in Spatial and Frequency Domain, Image Restoration & Image Segmentation and Morphological Operations & Representation and Description. The learners will be able to develop new algorithms, tools, and application software for real-world applications involving image processing.

iii. **COURSE OUTCOMES**

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

CO1	Explain the concepts of image formation and the basis of digital image processing.	Understand
CO2	Demonstrate the role of image transforms in representing, highlighting, and modifying image features.	Apply
CO3	Solve image enhancement problems using spatial and frequency domain techniques.	Apply
CO4	Make use of the concept of image restoration and image segmentation techniques in real-world problems.	Apply
CO5	Explain morphological operations in image processing	Understand

iv. **SYLLABUS**

Digital Image Fundamentals: Classification of Digital Images. Image Types. Image Storage Mechanisms. Arithmetic and Logical Operations. Geometric Spatial Transformations and Image Registration. Image File Formats. Colour Fundamentals and Colour Models. Image Transforms: Basic concept of spatial domain and frequency domain, Unitary transform, Discrete Fourier Transform, Discrete Cosine Transform, Forward and Inverse DCT, Hadamard Transform. Image Enhancement in Spatial and Frequency Domain: Point operations, Spatial Operations- Fundamentals of spatial convolution and correlation Basics of Filtering in Frequency Domain, Filters, Smoothing Frequency Domain Filters-Sharpening Frequency Domain Filters Image Restoration & Image Segmentation: Image degradation model, Noise models, Mean Filters, Order Statistic filter, Adaptive filters. Edge Detection, Thresholding, Region-Based Approach to Segmentation. Morphological Operations & Representation and

Description: Structuring Element, Dilation and Erosion, Opening and Closing, Hit or Miss Transformation. BoundaryFollowing. Chain Codes. Polygonal Approximation. Boundary Descriptors. Regional Descriptors. Relational Descriptors.

v.(a) TEXT BOOKS

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing (English) 3rd Edition, Pearson India, 2013
2. A K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

(b) OTHER REFERENCES

1. Al Bovik, The Essential Guide to Image Processing, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis, and Machine Vision, Thomson Learning, 2008.
3. S Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing, McGraw Hill Education, 2009.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Digital Image Fundamentals** Elements of Visual Perception, A Simple Image Formation Model, Spatial and Intensity Resolution, Image Interpolation, Classification of Digital Image, Image Types, Image Storage Mechanisms, Arithmetic and Logical Operations, Geometric Spatial Transformations and Image Registration, Image File Formats, Colour Fundamentals and Colour Models	7
II	**Image Transforms** Basic concept of spatial domain and frequency domain, Need of Image Transform, Basic properties of unitary transform, Discrete Fourier transform, Proof DFT is Unitary, 4 order DFT Transform coefficients (Derivation), Problems (4 order DFT), Discrete Cosine Transform- 2D DCT, 4 order DCT Transform Coefficients(No derivation needed), Hadamard Transform	10
III	**Image Enhancement in spatial and frequency domain** Point operations- Clipping and Thresholding, Digital Negative. Intensity Level Slicing, Bit Extraction, Range Compression + (Work out problems), Spatial Operations-Fundamentals of spatial convolution and correlation, Spatial averaging and spatial Low pass filtering, Directional Smoothing, Median Filtering, Unsharp masking and Crispening, Basics of Filtering in Frequency Domain, Smoothing Frequency Domain Filters : Ideal Low Pass Filter; Gaussian Low Pass Filter; Butterworth Low Pass Filter, Sharpening Frequency Domain Filters: Ideal High Pass Filter; Gaussian High Pass Filter; Butterworth High Pass filter	9

IV	**Image Restoration & Image Segmentation** Image degradation model, Noise models, Mean Filters – Order Statistic filter – Adaptive filters, Edge Detection, Gradient operators, Laplace operators and zero crossings, Thresholding- Basic Global Thresholding, Optimum global thresholding using Otsu method,Multiple thresholds, Variable thresholding, Multivariable thresholding,Region-Based Approach to Segmentation	10
V	**Morphological Operations & Representation and Description** Structuring Element. Dilation and Erosion, Morphological Opening, Closing, Hit or Miss Transformation, Boundary Following. Chain Codes, Polygonal Approximation, Boundary Descriptors, Regional Descriptors, Relational Descriptors	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
CS1U44D	INTERNET OF THINGS	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course equips the learners with fundamental of the Internet of Things(IoT) and the IoT ecosystem. It covers the architecture of IoT, communication mechanisms, protocols, hardware, software, data analytics, and the cloud platforms for IoT. This course enables the students to design smart IoT applications for real world problems using Raspberry Pi.

iii. **COURSE OUTCOMES**

After the completion of the course the students will be able to

CO1	Outline the fundamentals of IoT and its underlying physical and logical architecture.	Understand
CO2	Explain the hardware architectures for IoT	Understand
CO3	Outline the Network architectures for IoT	Understand
CO4	Implement data analytics on the IoT platforms	Apply
CO5	Interpret the security considerations in IoT	Understand
CO6	Implement IoT applications using the available hardware and software.	Apply

iv. **SYLLABUS**

IoT Architecture: IoT- Genesis, Impact, Challenges. IoT Network Architecture and Design, The Core IoT Functional Stack, IoT Data Management and Compute Stack. Engineering IoT Networks: Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. IoT Network Layer: IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. Data Analytics for IoT: An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security. Developing IoT Systems: IoT Logical Design using Python, IoT Physical Devices and Endpoints - RaspberryPi interfaces, Programming Raspberry Pi using Python, IoT Physical devices and Cloud offerings, Cloud Storage Models, WAMP - Autobahn for IoT, Django, Designing RESTful Web API, Cloud Web Services for IoT.

v. **(a) TEXT BOOKS**

1. 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).

2. Arshadeep Bahga, Vijay Madisetti, “Internet of Things: A hands-on approach”, University Press, 2015 (First edition)

(b) OTHER REFERENCES

1. Rajkamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill (India) Private Limited

2. Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011

3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013

4. Simon Monk, “Programming Arduino: Getting Started with Sketches”, McGraw Hill Publications

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**IoT Architecture** What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack	8
II	**Engineering IoT Networks** Smart Objects: The “Things” in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, IoT Access Technologies –IEEE 802.15.4 (g/e), 1901.2a, IoT Access Technologies - 802.11ah, LoRaWAN, IoT Access Technologies – LoRaWAN, NBIoT, LTE	9
III	**IoT Network Layer** IP as the IoT Network Layer, The Business Case for IP, The need for Optimizing IP for IoT, Optimizing IP for IoT, Profiles, and Compliance, Application Protocols for IoT – CoAP, Application Protocols for IoT – MQTT, The Transport Layer, IoT Application Transport Methods, The Transport Layer, IoT Application Transport Methods	9
IV	**Data Analytics for IoT** An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, A Brief History of OT Security, Common Challenges in OT Security, Differences between IT and OT Security Practices and Systems, Formal Risk Analysis Structures: OCTAVE and FAIR	10

V	**Developing IoT Systems** IoT Logical Design using Python, IoT Physical Devices and Endpoints, Raspberry Pi interfaces, Programming Raspberry Pi using Python, Other IoT devices, Cloud Storage Models, WAMP-Autobahn for IoT, Django, Designing RESTful Web API, Cloud Web Services for IoT	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U44E	SOFTWARE TESTING	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This is a course in theoretical computer science that introduces the concepts and methods in software testing. It covers various techniques for test case design used to test software artifacts, including requirements, design, and code, the different techniques for test case design based on graphs, programming language syntaxes and symbolic execution using PEX tool. It enables the learners to follow a systematic software testing approaches while developing applications.

iii. **COURSE OUTCOMES**

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

CO1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.	Understand
CO2	Illustrate using appropriate tools the mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	Apply
CO3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program.	Understand
CO4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.	Apply
CO5	Illustrate the use of PEX tool with symbolic execution.	Apply

iv. **SYLLABUS**

Introduction to Software Testing: Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria. Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing. Unit Testing: Concept of Unit testing- Static Unit testing, Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing. Mutation testing - Mutation and Mutants, Mutation operators, Mutation score. Junit - Framework for Unit testing. Unit Testing - White Box Approaches: Overview of Graph Coverage Criteria. Structural Graph Coverage Criteria ,Data Flow Criteria ,Class inheritance testing: Unit Testing - Black Box Approaches: Domain Testing / Input Space Partitioning ,Functional testing - Types of Functional testing, Black Box testing approaches using JUnit. Grey Box Testing Approaches: Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages. Techniques of Grey Box Testing

v.(a) TEXT BOOKS

1. Paul Ammann and JeffOffutt , Introduction to Software Testing, Cambridge University Press
2. Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice, Wiley.

(b) OTHER REFERENCES

1. King, James C, "Symbolic Execution and Program Testing", Association for Computing Machinery, July 1976.
2. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Fourth Edition

vi. COURSE PLAN

Module	Contents	No.of Hours
I	Introduction to Software Testing Some Popular Errors– Ariane 5, Therac 25, Intel Pentium Bug, What is Software testing? Why should it be tested? Software Quality, Role of Testing, Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking, Software Testing Terminologies- Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria, Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Functional testing, Stress testing, Performance testing, Usability testing and Regression testing, Testing Methods - Black Box testing, White Box testing, Grey Box testing.	9
II	Unit testing Concept of Unit testing, Static Unit Testing, Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, Functional Program testing, Mutation testing - Mutation and Mutants, Mutation operators, Mutation score, Junit - Framework for Unit testing, Case Study - Mutation testing using Junit, Case Study - Mutation testing using Muclipse	8
III	Unit Testing:- White Box Approaches Structural Graph Coverage Criteria - Node/vertex coverage, Edge coverage, Edge pair coverage, Path coverage, Complete path coverage, Prime path coverage, Complete round trip coverage, Simple round trip coverage, Data Flow Criteria - du paths, du pairs, Subsumption Relationships among Graph Coverage Criteria, Graph Coverage for Source Code – Control Flow Graphs (CFG) for code, CFG: If statement, CFG: If statement with return, CFG: Switch-case, CFG: Loops, CFG: Exceptions (try-catch). Example program – Statistics, Graph Coverage for Design Elements – Structural graph coverage and data flow graph coverage for design elements, Case Study - Graph Based testing using JUnit Framework, Case Study - Graph Based testing using JUnit Framework, Case study- graph based testing using JUnit Framework	10

IV	Unit Testing:- Black Box Approaches Domain Testing / Input Space Partitioning - Partitions of a set, Input domain modelling - Interface-based approach, Functionality-based approach, Multiple partitions of the input domain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base Choice Coverage, Multiple Base Choices Coverage, Functional Testing - Functional Testing Concepts of Howden. Important Steps, Types of Functional testing - Equivalence Class Partitioning, Boundary Value Analysis, Decision Tables, Random Testing, Case Study - Black Box testing approaches using JUnit	9
V	Grey Box Testing Approaches Introduction to Grey Box testing - Why Grey Box testing, Gray Box Methodology, Advantages and Disadvantages, Techniques of Grey Box Testing - Matrix Testing, Regression Testing, Orthogonal Array Testing or OAT, Pattern Testing, An Introduction to Pex - Parameterized Unit Testing, The Testing Problem, Symbolic Execution – Example, Symbolic execution tree, Case Study – PEX Case Study – PEX Case Study – PEX	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks

Continuous Assessment Assignment : 15 marks

Total Marks : 50 marks

vii. Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U44F	BIOINFORMATICS	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

This course helps the learners to understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling. This course introduces bio macromolecules such as genes and proteins, different biological databases, and tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology. This course enables the learners to contribute towards drug discovery and computational analysis and modelling of biological process.

iii. **COURSE OUTCOMES**

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

CO 1	Describe the basic concepts of Bioinformatics with an emphasis on structure, function and synthesis of biomolecules .	Understand
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio-sequences to identify similarity .	Apply
CO 3	Employ similarity searching tools and algorithms to align sequences to highlight the similarity, and describe the structure of genes .	Apply
CO 4	Demonstrate Protein Structure, visualize protein structure using tools, and explain how proteins interact.	Apply
CO 5	Explain the fundamental aspects of Systems Biology, Computational Modeling and properties of models .	Understand

iv. **SYLLABUS**

Introduction to bioinformatics: Introduction to bioinformatics, Nature & Scope of Bioinformatics, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation

Introduction to bio sequences and analysis: Introduction to Biological Databases, NCBI, Genbank, Bio sequence formats- FASTA, Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices - PAM and BLOSUM

Database Similarity Searching and genomics: Database Similarity Searching, BLAST – Variants - BLASTN, BLASTP, BLASTX, Statistical Significance, Needleman and Wunsch and Smith–Waterman

Method, Multiple Sequence Alignment, scoring function, Clustal, introduction to structure of prokaryotic and eukaryote gene

Proteomics: Protein Structure, Ramachandran Plot, Hierarchies of Protein Structure,Determination of Protein three-dimensional structure, protein structure database-PDB, Protein structure visualization, introduction to Protein protein interaction, STRING database

Systems Biology: Introduction to Systems Biology, Models and Modelling, Properties of models, Systems state and steady state, Variables, Parameters, and Constants in modelling, Purpose and Adequateness of Models, Advantages of Computational Modelling, Model Development, Network Versus Elements, Modularity, Robustness and Sensitivity, Data Integration

v. (a) TEXT BOOKS

1. Zvelebil, Marketa J., and Jeremy O. Baum. *Understanding bioinformatics*. Garland Science, 2007.
2. Xiong, Jin. *Essential bioinformatics*. Cambridge University Press, 2006.
3. Klipp, E., Herwig, R., Kowald, A., Wierling, C., &Lehrach, H. *Systems biology in practice: concepts, implementation and application*. John Wiley & Sons. 2005

(b) OTHER REFERENCES

1. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. John Wiley & Sons, 2020.
2. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I.* Springer, 2019
3. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics. An introduction–Springer, Verlag,*, 2008.
4. S C Rastogi, N Mendiratta and PRastogi, *Bioinformatics: Methods and Applications* , PHI Learning Private Limited, New Delhi, 2015.
5. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education, 2006.
6. Andreas D.Baxevanis, B F Francis Ouellette, *Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins*, Third Edition, John Wiley & Sons INC. , U.K. 2006
7. Neil C Jones and Pavel A Pevzner, *An Introduction to Bioinformatics Algorithms*, MIT press, 2004.

vi. COURSE PLAN

Module	Contents	No. of Hours
I	**Introduction to bioinformatics** Introduction to bioinformatics, Nature & Scope of Bioinformatics, DNA, RNA, and Protein, The Central Dogma introduction, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, Translation	7

II	**Introduction to bio sequences and analysis** Introduction to Biological Databases, NCBI Sequence retrieval, Genbank, Bio sequence formats- FASTA, Sequence alignment- Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices – PAM, BLOSUM	9
III	**Database Similarity Searching and genomics** Database Similarity Searching, BLAST, Variants of BLAST -BLASTN, BLASTP, BLASTX, BLAST Analysis - Statistical Significance, Needleman and Wunsch Method, Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal tool, Gene Structure of prokaryotic, eukaryote	10
IV	**Proteomics** Protein Structure, Ramachandran Plot, Hierarchies of Protein Structure, Determination of Protein three-dimensional structure, protein structure database-PDB, Protein structure visualization, Protein protein interaction, Protein protein interaction networks, STRING database	10
V	**Systems Biology** Introduction to Systems Biology, Properties of models, Systems state and steady state, Variables, Parameters, and Constants in modelling, Purpose and Adequateness of Models, Advantages of Computational Modelling ,Model Development (introduction only), Network Versus Elements, Modularity, Robustness and Sensitivity, Data Integration	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1U44G	COMPUTATIONAL LINGUISTICS	PEC	2	1	0	3	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The course aims to teach the basics of Computational Linguistics to the students viewing language phenomena from a computational/statistical standpoint. This involves ideas about statistical and computational models and how these could be linked with various language processing tasks. The course helps the learner to appreciate the complexities involved in language processing tasks using a machine, in contrast with the ease with which human beings handle them. Some practical aspects are also discussed using the Python and NLTK framework to equip the student with the capability to design solutions to linguistic problems.

iii. **COURSE OUTCOMES**

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

CO1	Explain the fundamental concepts of language processing.	Understand
CO2	Demonstrate the concepts of probability, statistical inference and hidden Markov model.	Apply
CO3	Compare and summarize the various methods of word sense disambiguation, lexical acquisition and selectional preferences.	Apply
CO4	Make use of different Part-of-Speech Tagging methods for language modelling.	Apply
CO5	Examine Probabilistic Context Free Grammars and various probabilistic parsing methods	Apply
CO6	Develop simple systems for linguistic tasks using Python and NLTK.	Apply

iv. **SYLLABUS**

Introduction to Computational Linguistics, The Ambiguity of Language, Linguistic Essentials, Parts of Speech and Morphology, Phrase structure grammars, Probability Theory, Bayes' theorem, Statistical Inference, n-gram Models, Markov Models, Word Sense Disambiguation, Dictionary based Disambiguation, Evaluation Measures, Semantic Similarity- Vector space measures-Probabilistic measures, Grammar - Part-of-Speech Tagging, Probabilistic Context Free Grammars, Language Processing with Python-Introduction to NLTK.

v. **(a) TEXT BOOKS**

1. C.D. Manning and H. Schutze. Foundations of Statistical Natural Language Processing. MIT Press.
2. Steven Bird, fEwan Klein, fEdward Loper, Natural Language Processing with Python and NLTK. O’reilly Pub.

(b) OTHER REFERENCES

1. D. Jurafsky and J.H. Martin: Speech and Language Processing: Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, PHI.James Allen: Natural Language Understanding. Pearson Pub.
2. Nitin Hardeniya, Jacob Perkins, Deepti Chopra, Nisheeth Joshi, ItiMathur: Natural Language Processing: Python and NLTK., **1**stEdition. Packt Publishing

vi. COURSE PLAN

Module	Contents	No.of Hours
I	**Preliminaries** Introduction: Rationalist and Empiricist Approaches to Language-Questions that linguistics should answer, Non-categorical phenomena in language-Language and cognition as probabilistic phenomena, The Ambiguity of Language: Why natural language processing is difficult, Lexical resources-Word counts, Zipf's laws-Collocations-Concordances, Linguistic Essentials: Parts of Speech and Morphology -Nouns and pronouns, Words that accompany nouns: Determiners and adjectives-Verbs-Other parts of speech, Phrase Structure-Phrase structure grammars, Semantics and Pragmatics-Corpus Based Work	8
II	**Mathematical Essentials** Probability Theory-Probability spaces, Conditional probability and independence-Bayes' theorem, Random variables-Expectation and variance-Notation, Joint and conditional distributions-Standard distributions-Bayesian statistics, Statistical Inference: n-gram Models over Sparse Data-Bins: Forming Equivalence Classes, Markov Models-Hidden Markov Models: Why use HMMs?, General form of an HMM-Finding the probability of an observation-Finding the best state sequence	9
III	**Word Sense Disambiguation** Methodological Preliminaries-Supervised and unsupervised learning, Upper and lower bounds on performance-Supervised Disambiguation, Bayesian classification-Dictionary based Disambiguation, Disambiguation based on sense definitions-Thesaurus based disambiguation, Lexical Acquisition-Evaluation Measures, Verb Subcategorization-Attachment Ambiguity, PP attachment-Selectional Preferences, Semantic Similarity:Vector space measures-Probabilistic measures	10

IV	**Grammar** Part-of-Speech Tagging-The Information Sources in Tagging, Markov Model Taggers-Hidden Markov Model Taggers, Applying HMMs to POS tagging-The effect of initialization on HMM training, Transformation-Based Learning of Tags, Probabilistic Context Free Grammars-Some Features of PCFGs, Questions for PCFGs, The Probability of a String -Using inside probabilities Using outside probabilities, Finding the most likely parse for a sentence-parsing for disambiguation, parsing model *vs.* language model	9
V	**Language Processing with Python** Introduction to NLTK, Text Wrangling and Text cleansing : Sentence Splitter, Tokenization, Stemming, Lemmatization, Stop word removal , Rare word Removal, Spell Correction, Part of Speech Tagging and NER, Parsing Structure in Text: Shallow versus deep parsing, types of parsers	9
	Total hours	**45**

vi. Continuous Assessment Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (Average of Series Tests 1& 2) : 25 marks
Continuous Assessment Assignment : 15 marks
Total Marks : 50 marks

vii. Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

MINOR

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS0M49B	MINI PROJECT	PWS	0	1	6	4	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The objective of this course is to apply the fundamental concepts of different courses learned in respective Minor Streams: Software Engineering, Machine Learning and Networking. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification &design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

iii. **COURSE OUTCOMES**

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

CO1	Identify technically and economically feasible problems .	Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions.	Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques .	Apply
CO4	Prepare technical report and deliver presentation .	Apply
CO5	Apply engineering and management principles to achieve the goal of the project.	Apply

iv. **COURSE PLAN**

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two

reviews.
The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

v. ASSESMENT PATERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	1 Hour

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

HONOURS

Course Code	Course Name	Category	L	T	P	Credit	Year Of Introduction
CS1H49A	MINI PROJECT	PWS	0	1	6	4	2020

i. **PRE-REQUISITE:** Nil

ii. **COURSE OVERVIEW**

The objective of this course is to apply the fundamental concepts of courses learned in respective Honors Streams: Security in Computing, Machine Learning and Formal Methods. This course helps the learners to get an exposure to the development of application software/hardware solutions/ software simulations in the field of Computer Science and Engineering. It enables the learners to understand the different steps to be followed such as literature review and problem identification, preparation of requirement specification &design document, testing, development and deployment. Mini project enables the students to boost their skills, widen the horizon of thinking and their ability to resolve real life problems.

iii. **COURSE OUTCOMES**

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

CO1	Identify technically and economically feasible problems .	Apply
CO2	Identify and survey the relevant literature for getting exposed to related solutions.	Apply
CO3	Perform requirement analysis, identify design methodologies and develop adaptable & reusable solutions of minimal complexity by using modern tools & advanced programming techniques.	Apply
CO4	Prepare technical report and deliver presentation .	Apply
CO5	Apply engineering and management principles to achieve the goal of the project .	Apply

iv. **COURSE PLAN**

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

v. ASSESMENT PATERN

Mark distribution

Total Marks	Continuous Internal Evaluation Marks	End Semester Evaluation Marks	End Semester Examination Duration
150	75	75	1 Hour

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstrationof functionality	25
Project Report	10
Viva-voce	20
Presentation	10