MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B. Tech

COMPUTER SCIENCE AND ENGINEERING

(Artificial Intelligence)

CURRICULUM

FOR

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING
(Artificial Intelligence)

2022 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

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING (Artificial Intelligence)

CURRICULUM AND DETAILED SYLLABI

2022 SCHEME

Items	Board of Studies(BOS)	Academic Council(AC)
Date of Approval	16.08.2022	21.11.2022
	28/02/2023	
	26/03/2024	

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)

PEO1: Graduates will be successful professionals in Industries of core or interdisciplinary natureor entrepreneurs, demonstrating effective leadership and excellent team work.

PEO2: Graduates will expand the horizon of knowledge through higher education or research, leading to self-directed professional development

PEO3: Graduates will demonstrate competency in AI & ML, professional attitude and ethics whileproviding 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)

PSO1: To apply Algorithmic Principles, Programming Skills and Software Engineering Principlesto design, develop and evaluate Software Systems of varying complexities.

PSO2: To apply knowledge of System Integration to design and implement computer-based systems

PSO3: To solve real world and socially relevant problems using AI and ML techniques

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.Tech. Programme in Computer Science and Engineering

(Artificial Intelligence)

For the students admitted from 2022-23

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	03
7	Project Work and Seminar	PWS	10
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	Non-Credit
9	Mandatory Student Activities (P/F)	MSA	2
Total Mandatory Credits			**162**

ii) Semester-wise Credit Distribution

Semester	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*Total*
Credits for Courses	20	18	22	22	24	22	15	17	***160***
Activity Points (Min.)	*40*				*60*				***100***
Credits for Activities	*2*								***2***
Total Credits									***162***

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 ½	BSC	PH0U10C	Engineering Physics-C	2-1-0	3	3
		CYOU10B	Engineering Chemistry-B	2-1-0	3	3
C ½	ESC	ES0U10A	Engineering Mechanics	2-1-0	3	3
		ES0U10B	Engineering Graphics	2-0-2	4	3
D ½	ESC	ES0U10C	Basics of Civil and Mechanical Engineering	4-0-0	4	4
		ES0U10D	Basics of Electrical and ElectronicsEngineering	4-0-0	4	4
E	HSC	HS0U10A	Life Skills	2-0-2	4	---
F	ESC	ES0U10G	Problem Solving & Programming in C	3-0-2	5	4
S ½	BSC	PHOU18A	Physics Lab	0-0-2	2	1
		CYOU18A	Chemistry Lab	0-0-2	2	1
T ½	ESC	ES0U18A	Civil and Mechanical Workshop	0-0-2	2	1
		ES0U18B	Electrical and Electronics Workshop	0-0-2	2	1
			TOTAL		**27/28**	**20**

SEMESTER II						
Slot	**Category Code**	**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	PH0U10C	Engineering Physics-C	3-0-0	3	3
		CYOU10B	Engineering Chemistry-B	3-0-0	3	3
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	ES0U10H	Introduction to Python	2-0-0	2	2
S 1/2	BSC	PHOU18A	Physics Lab	0-0-2	2	1
		CYOU18A	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					**24/25**	**18**

SEMESTER III

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
A	BSC	MA0U20G	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	CS2U20A	Object Oriented Programming using Python	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	NC0U20B	Constitution of India	2-0-0	2	---
S	PCC	CS1U28A	Data Structures Lab	0-0-3	3	2
T	PCC	CS2U28A	Object Oriented Programming Lab (in Python)	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	MA0U20F	Mathematics for Artificial Intelligence	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	CS2U20B	Introduction to Artificial Intelligence	3-1-0	4	4
E ½	ESC	ES0U20A	Design and Engineering	2-0-0	2	2
	HSC	HS0U20A	Professional Ethics	2-0-0	2	2
F	MNC	NC0U20C	Universal Human Values-II	2-0-0	2	---
S	PCC	CS2U28B	AI Algorithms Lab	0-0-3	3	2
T	PCC	CS1U28E	Database Management 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	CS1U30K	Operating Systems	3-1-0	4	4
D	PCC	CS2U30C	Introduction to Machine Learning	3-1-0	4	4
E	PCC	CS2U30D	Artificial Neural Network	3-1-0	4	4
F	MNC	NC0U30A	Disaster Management	2-0-0	2	---
S	PCC	CS2U38A	Operating Systems and Networking Lab	0-0-4	4	2
T	PCC	CS2U38B	Machine Learning Lab	0-0-4	4	2
R/M/H	VAC		Remedial/Minor/HonoursCourse	3-1-0	4	4
TOTAL					**30/34**	**24/28**

SEMESTER VI						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS2U30E	Robotics and Intelligent System	3-1-0	4	4
B	PCC	CS1U30H	Algorithm Analysis and Design	3-1-0	4	4
C	PCC	CS1U30E	Management of Software Systems	3-0-0	3	3
D	PEC	CS2UXXX	Program elective I	2-1-0	3	3
E	HSC	HS0U30A	Industrial Economics & Foreign Trade	3-0-0	3	3
F	PCC	CS2U30I	Comprehensive Course Work	1-0-0	1	1
S	PCC	CS2U38C	Robotics Lab	0-0-3	3	2
T	PWS	CS2U39A	Mini Project	0-0-3	3	2
R/M/H	VAC		Remedial/Minor/Honours Course	3-1-0	4	4
TOTAL					**24/28**	**22/26**

PROGRAMME ELECTIVE I

Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
D	PEC	CS2U31A	Intelligent Model Design and Thinking	2-1-0	3	3
		CS2U31B	Concepts in computer graphics and image processing	2-1-0	3	3
		CS1U31C	Foundations of security in computing	2-1-0	3	3
		CS2U31C	Object Oriented Programming using Java	2-1-0	3	3
		CS2U31E	Programming in R	2-1-0	3	3
		CS2U31F	Machine Learning models and Storage Management	2-1-0	3	3

SEMESTER VII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS2U40A	Foundations of Deep Learning	2-1-0	3	3
B	PEC	CS2UXXX	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	CS2U48A	Deep Learning Lab	0-0-3	3	2
T	PWS	CS2U49A	Seminar	0-0-3	3	2
U	PWS	CS2U49B	Project Phase I	0-0-6	6	2
R/M/H	VAC		Remedial/Minor/HonoursCourse	0-1-6/ 3-1-0	7/4	4
TOTAL					**24 (31/28)**	**15/19**

PROGRAMME ELECTIVE II

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
D	PEC	CS2U41A	Big data Analytics	2-1-0	3	3
		CS2U41B	Social Network Analysis	2-1-0	3	3
		CS2U41C	Data Mining	2-1-0	3	3
		CS2U41D	AI for Health Care	2-1-0	3	3
		CS2U41E	Game Theory in Artificial Intelligence	2-1-0	3	3
		CS1U41F	Natural Language Processing	2-1-0	3	3
		CS2U41F	Cloud Data Management	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 and Image Processing	2-1-0	3	3
		CS0U41D	Python for Engineers	2-1-0	3	3
		CS0U41E	Object Oriented Concepts	2-1-0	3	3
		CS0U41F	Introduction to AI and ML	2-1-0	3	3

SEMESTER VIII						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P**	**Hours**	**Credit**
A	PCC	CS2U40B	Robotic Process Automation	2-1-0	3	3
B	PEC	CS2UXXX	Programme Elective III	2-1-0	3	3
C	PEC	CS2UXXX	Programme Elective IV	2-1-0	3	3
D	PEC	CS2UXXX	Programme Elective V	2-1-0	3	3
T	PCC	CS2U40C	Comprehensive Course Viva	1-0-0	1	1
U	PWS	CS2U49C	Project Phase II	0-0-12	12	4
R/M/H	VAC		Remedial/Minor/HonoursCourse	0-1-6	7	4
TOTAL					**25/32**	**17/21**

PROGRAMME ELECTIVE III

Slot	Category Code	Course Number	Course	L-T-P	Hours	Credit
B	PEC	CS2U42A	AI For Cyber Security	2-1-0	3	3
		CS2U42B	Web Intelligence and Big Data	2-1-0	3	3
		CS2U42C	Cognitive Modelling	2-1-0	3	3
		CS2U42D	Image and Video Analytics	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
B	PEC	CS2U43A	Human Computer Interaction	2-1-0	3	3
		CS2U43B	Deep Learning for Signal & Image Processing	2-1-0	3	3
		CS2U43C	Artificial Intelligence for Robotics	2-1-0	3	3
		CS2U43D	Data Pre-processing and Feature Engineering	2-1-0	3	3
		CS2U43F	Introduction to Reinforcement Learning	2-1-0	3	3
		CS2U43G	Bio-Inspired Optimization Techniques	2-1-0	3	3
		CS2U43H	Text Mining	2-1-0	3	3

PROGRAMME ELECTIVE V

Slot	Category Code	Course Number	Courses	L-T-P	Hours	Credit
C	PEC	CS1U44A	High Performance Computing	2-1-0	3	3
		CS1U44B	Block Chain Technologies	2-1-0	3	3
		CS2U44A	Knowledge Engineering and Expert Systems	2-1-0	3	3
		CS2U44B	IoT for AI	2-1-0	3	3
		CS2U44C	Big Data and Database Management	2-1-0	3	3
		CS1U44F	Bioinformatics	2-1-0	3	3
		CS1U44G	Computational Linguistics	2-1-0	3	3

B. Tech (MINOR)

Semester	BASKET I SOFTWARE ENGINEERING				BASKET II ARTIFICIAL INTELLIGENCE & MACHINE LEARNING				BASKET III NETWORKING			
	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit	Course Number	Course	L-T-P	Credit
S3	CS0M 20A	Object Oriented Programming	3-1-0	4	CS0M 20B	Python for Machine Learning	3-1-0	4	CS0M 20C	Data Communication	3-1-0	4
S4	CS0M 20D	Programming Methodologies	3-1-0	4	CS0M 20E	Mathematics for Machine Learning	3-1-0	4	CS0M 20F	Introduction to Computer Networks	3-1-0	4
S5	CS0M 30A	Concepts in Software Engineering	3-1-0	4	CS0M 30B	Concepts in Machine Learning	3-1-0	4	CS0M 30C	Internet Of Things	3-1-0	4
S6	CS0M 30D	Introduction to Software Testing	3-1-0	4	CS0M 30E	Concepts in Deep Learning	3-1-0	4	CS0M 30F	Wireless Networks and IoT Applications	3-1-0	4
S7	CS0M 49A	Mini Project	0-1-6	4	CS0M 49A	Mini Project	0-1-6	4	CS0M 49A	Mini Project	0-1-6	4
S8	CS0M 49B	Mini Project	0-1-6	4	CS0M 49B	Mini Project	0-1-6	4	CS0M 49B	Mini Project	0-1-6	4

B. Tech (HONOURS)

Semester	BASKET I				BASKET II				BASKET III			
	SECURITY IN COMPUTING				COMPUTATIONAL BIOLOGY				COMPUTER VISION			
	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	CS2H20A	Computational Fundamentals for Bioinformatics	3-1-0	4	CS2H20B	Advanced Topics in Computer Graphics	3-1-0	4
S5	CS1H30A	Cryptographic Algorithms	3-1-0	4	CS2H30A	Computational Biology	3-1-0	4	CS2H30B	Advanced Concepts In Computer Vision	3-1-0	4
S6	CS1H30D	Network Security	3-1-0	4	CS2H30C	Machine Learning In Computational Biology	3-1-0	4	CS2H30D	Image And Video Processing	3-1-0	4
S7	CS1H40A	Cyber Forensics	3-1-0	4	CS2H40A	Computational Health Informatics	3-1-0	4	CS2H40B	Surveillance Video Analytics	3-1-0	4
S8	CS1H49A	Mini Project	0-1-6	4	CS2H49A	Mini Project	0-1-6	4	CS2H49A	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	2022

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 familiarizes students with some basic techniques in matrix theory which are essential for analyzing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analyzing 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.	Apply
CO 3	Compute areas and volumes of geometrical shapes using multiple integrals.	Apply
CO 4	Identify the convergence or divergence of an infinite series.	Apply
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, eigenvalues and eigenvectors, 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 center 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, 10th Edition, 2016.

REFERENCES

1) J.Stewart, *Essential Calculus*, Cengage, 2nd Edition, 2017.

2) G.B.Thomas and R.L.Finney, *Calculus and Analytic geometry*, 9th 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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U10C	ENGINEERING PHYSICS-C	BSC	2	1	0	3	2022

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 urgein 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	Understand
CO 2	Explain natural physical processes and related technological advances usingprinciples of optics	Understand
CO 3	Generalize the principle of quantum mechanics to explain the behavior of matter inthe atomic and subatomic level	Understand
CO 4	Relate the fundamental ideas of magnetism and vector calculus to arrive at Maxell'sequations	Understand
CO 5	Describe the fundamentals of superconductivity and fibre optics for variousengineering applications	Understand

SYLLABUS

Oscillations and Waves: Oscillations - Introduction, 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- 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, Applications

Magnetism & Electro Magnetic Theory: Magnetic field and Magnetic flux density, magnetic permeability and susceptibility, classification of magnetic materials, fundamentals of vector calculus, equation of continuity, Maxwell's equations in vacuum.

Superconductivity & Fibre Optics: Super conductivity- Meissner effect, Type I & II superconductors, applications of superconductors, Optical fibre -Principle, Numerical aperture, Types of fibres, Applications

(a) 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

(b) REFERENCES

1) Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw Hill Publications, 6th Edition, 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*, Addison-Wesley publishing, 4th Edition, 1999.
5) Premlet B., *Advanced Engineering Physics*, Phasor Books,10th Edition, 2017.

COURSE PLAN

Module	Contents	No. of hours
I	Oscillations and Waves: Harmonic oscillations, 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 (no derivation), three-dimensional wave equation and its solution (no derivation), transverse vibration in a stretched string, statement of laws of vibration	**9**
II	Wave Optics: Interference of light- theory of thin films - cosine law (no derivation), 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, Comparison of 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)	**9**
III	Quantum Mechanics & Nanotechnology: Introduction for the need of Quantum mechanics, wave nature of Particles, uncertainty principle, Applications-absence of electrons inside a nucleus, formulation of time dependent and time- independent Schrodinger wave equations, Particle in a one dimensional box- derivation for normalised wave function and energy eigen values, Quantum mechanical tunnelling (qualitative). Introduction to nanoscience and technology, surface to volume ratio for nanomaterials, quantum confinement in one dimension, two dimension and three dimension-nano sheets, nano wires and quantum dots, applications of nanotechnology (qualitative ideas)	**9**
IV	Magnetism and Electromagnetic theory: Magnetic field and Magnetic flux density, Magnetic permeability and susceptibility, classification of magnetic materials-para, dia and ferromagnetic materials Fundamentals of vector calculus, equation of continuity, derivation of Maxwell's equations in vacuum, comparison of displacement current with conduction current	**9**
V	Superconductivity: Superconducting phenomena, Meissner effect and perfect diamagnetism, types of Superconductors-Type I and Type II 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.	**9**
	Total hours	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10A	ENGINEERING MECHANICS	ESC	2	1	0	3	2022

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, 12th Edition, 2005.
3) Bansal, R. K., *A Textbook of Engineering Mechanics*, Laxmi Publications, 8th Edition, 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, 7th Edition, 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	9

	translation).	
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 (conceptonly). 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).	9
	Total hours	45

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10C	BASICS OF CIVIL AND MECHANICAL ENGINEERING	ESC	4	0	0	4	2022

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, 4th Edition, 2017.
2) Rangwala, S. C., *Essentials of Civil Engineering*, Charotar Publishing House, 1st 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), 2ndEdition, 2002
2) Punmia, B. C., Ashok, K. J. and Arun, K. J., *Surveying*, Vol. I, Laxmi Publications (P) ltd., New Delhi, 17thEdition, 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; 3rd 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	10

	(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.	
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.	10

	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.	
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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10A	LIFE SKILLS	HSC	2	0	2	-	2022

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., VishnuR.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: Howto 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, 1stEdition,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. **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 Thinking Hats, Mind Mapping, Forced Connections.	6
	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.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10G	PROBLEM SOLVING & PROGRAMMING IN C	ESC	2	1	2	4	2022

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.

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.

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 IOOperations, printf and scanf, Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignmentoperators 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 files: In built file handling functions (rewind (), fseek (), ftell (), feof (), fread (), fwrite ()), simple programs covering pointers and files.	**11**
	Total hours	**45**

C PROGRAMMING LAB (Practical Partof 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 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.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
PH0U18A	ENGINEERING PHYSICS LAB	BSC	0	0	2	1	2022

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	Apply the theory of stretched string to determine the frequency of tuning fork using a Melde's string apparatus.	Apply
CO 2	Identify different wave patterns using CRO to determine the wave parameters.	Apply
CO 3	Determine the wavelength of a monochromatic beam of light and thickness of thin wire using principle of interference	Apply
CO 4	Make use of the ideas of diffraction to determine the wavelengths of a light using plane transmission grating.	Apply
CO 5	Experiment with non ohmic devices to draw the I-V characteristics	Apply

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 transmissiongrating.
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.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18A	CIVIL AND MECHANICAL WORKSHOP	ESC	0	0	2	1	2022

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 workshoptrades.	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 thicknessof 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 (differentiallevelling).

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, 43rd Edition, 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, 1st Edition, 2022.

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	2022

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	Apply
CO 2	Evaluate surface and volume integrals and learn their inter-relations and applications.	Apply
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, 10th Edition, 2015.
2) ErwinKreyszig, *Advanced Engineering Mathematics*, JohnWiley&Sons, 10th Edition, 2016.

REFERENCES

1) George F Simmons*: Differential Equation with Applications and its historical Notes*, McGraw Hill Education India, 2nd Edition, 2002.
2) HemenDutta, *Mathematical Methods for Science and Engineering*, CengageLearning,1st Edition, 2020.
3) B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44th 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) orx = 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	12

	differential equations using Laplace transform, Unit step function, Second shifting theorems. Dirac delta function and its Laplace transform, Solution of ordinary differential 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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U10B	ENGINEERING CHEMISTRY-B	BSC	2	1	0	3	2022

i) 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.

ii) COURSE OUTCOMES

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

CO 1:	Solve various engineering problems by applying the basic concepts of Electrochemistry.	Apply
CO 2:	Apply the basic concepts of UV-Visible spectroscopic techniques in the analysis of organic compounds and in conducting polymers.	Apply
CO 3:	Interpret IR and NMR spectrum of simple molecules.	Apply
CO 4:	Explain the use of analytical methods such as TG, DTA and SEM for analysis of chemical mixtures and characterization of nanomaterials.	Understand
CO 5:	Examine the various types of hardness in water and their elimination.	Apply

iii) SYLLABUS

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

UV-Visible Spectroscopic Technique and Polymer Chemistry: – Types of spectrum, Beer Lambert's law, Principles and applications of UV-Visible spectroscopy, instrumentation of UV-Visible spectroscope, Basics of polymer chemistry, BS, ABS, Kevlar and conducting polymers.

IR and NMR Spectroscopic techniques with applications: - Principles and applications of IR and NMR spectroscopy, Chemical shift, Spin spin splitting.

Thermal Analytic Techniques and Nanomaterials: – TG, DTA techniques; Classifications of nanomaterials, synthesis, properties and applications, SEM.

Water Chemistry–Types of hardness in water and its elimination, Reverse osmosis, DO, BOD, COD and its significance.

iv) (a) TEXT BOOKS

1) D. Harvey, N. Rutledge, *Industrial Chemistry*, ETP, first edition, 2018. ISBN: 9781788820554

2) P. W. Atkins, J de Paula, *Atkins' Physical Chemistry*, Oxford University Press, 11'th edition 2014. ISBN: 9780199697403

3) M. Arif, A. Fernandez, K. P. Nair, *Engineering Chemistry*, first edition, Owl Books,2019.

4) S. Chawla, *A text book of Engineering Chemistry*, second edition, Dhanpat Rai & Co. 2013.

5) Roy V., *Engineering Chemistry*, Second Edition, 2019.

(b) OTHER REFERENCES

1) C. N. Banwell, E. M. Mc Cash, *Fundamentals of Molecular Spectroscopy*, McGraw-Hill, 4th edition, 2001. ISBN: 9780074620250

2) , H. H. Willard, L. L. Merritt,*Instrumental Methods of Analysis*, CBS Publishers, 7th edition, 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

Course Plan		
Module	**Contents**	**No. of hours**
I	**Electrochemistry and corrosion:** Electrochemical series and its applications. Free energy and EMF -Nernst Equation – Derivation – single electrode and cell (Numericals) –Application - Variation of EMF with temperature. Potentiometric titration - Introduction -Redox titration only. Lithium ion cell - construction and working. Corrosion-Electrochemical corrosion – mechanism. Galvanic series- cathodic protection	9
II	**UV-Vis Spectroscopic Technique and Polymer Chemistry:** 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. 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.	**9**
III	**IR and NMR Spectroscopic techniques with 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 problems) - coupling constant (definition) - applications of NMR- including MRI (brief).	**9**
IV	**Thermal Analytic Techniques 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 $CaC_2O_4.H_2O$. Nanomaterials - Definition - Classification - Chemical methods of preparation -Hydrolysis and Reduction - Applications of nanomaterials – Surface characterisation -SEM – Principle and instrumentation (block diagram).	**9**
V	**Water Chemistry:** 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 (Numericals).	**9**

	Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance	
	Total hours (Approx.)	**45**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10B	ENGINEERING GRAPHICS	ESC	2	0	2	3	2022

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 CADtools.	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 positionincluding 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 pyramidswith axis perpendicular to the ground plane, axis perpendicular to picture plane.	5

	Conversion of pictorial view: Conversion of pictorial view intoorthographic 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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U10D	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	ESC	4	0	0	4	2022

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 simpleAC 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, 5th Edition,2009.
4) Boylested, R. L. and Nashelsky, L., *Electronic Devices and Circuit Theory*, Pearson Education, 10thEdition, 2009.
5) Wayne Tomasi and Neil Storey, *A Textbook on Basic Communication and Information Engineering*, Pearson, 5thEdition, 2010.

REFERENCES

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

COURSE PLAN

Module	**Contents**	**No. of hours**
I	**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.	**9**
	Analysis of DC circuits: Mesh current method, Node voltage method. Solution of network equations by matrix method, Numerical problems.	
	Magnetic Circuits: Review of Magnetic Circuits, Series magnetic circuits with composite materials, Numerical problems.	
II	**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.	**9**

	Alternating Current fundamentals: Generation of alternating voltages, Basic definitions, Average and RMS values of sinusoidal waveforms, Numerical Problems.	
	Power Generating Stations: Solar, Wind, Hydro-electric and Nuclearpower 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, GNU Radio or similar software to augment the understanding.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
HS0U10B	PROFESSIONAL COMMUNICATION	HSC	2	0	2	--	2022

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	Demonstrate effective communication skills through writing and making presentations	Create
CO 2	Analyze a variety of textual and audio content for specific needs	Analyze
CO 3	Evaluate a given technical/non-technical topic	Evaluate
CO 4	Create professional and technical documents	Create
CO 5	Communicate proficiently in interviews and exam situations and all social situations	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, 3rd Edition, 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*, 4th Edition, Pearson, 1999.
4. David F. Beer and David, *Guide to writing as an Engineer*, John Willey. New York, 2004.
5. Goodheart-Willcox, *Professional Communication*, 1st Edition, 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, 5th Edition, 2016.
9. Raman Sharma, *Technical Communications*, Oxford Publication, London, 2004.

COURSE PLAN

Module	**Contents**	**No. of hours**
I	Use of language in communication: Difference between technical and literary style. 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. Technology-based communication: Effective email messages, Netiquette, editing skills using software. Modern day research and study skills: search engines, repositories, forums such as Git Hub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism	4

II	Reading, Comprehension, and Summarizing: Reading styles, speed reading, critical reading, reading and comprehending shorter and longer technical articles from journals, newspapers, identifying the various transitions in a text. Interpreting data in tables and figures Comprehension: techniques, marking and underlining, Note-taking and note making, 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. presentations and Technical presentation including Slide presentation Debate and Group Discussions: Difference between GD and debate; brainstorming the topic, questioning and clarifying, GD strategies, activities to improve GD skills	10
IV	Listening 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.	5
V	Interview skills and Formal writing: Interview Skills: types of interviews, successful interviews, interview etiquettes, dress code, body language, telephone/online interviews, one-to-one interview & panel interview, FAQs related to job interviews Formal Writing: Letter Writing (formal, informal and semi formal), Job applications, Minute preparation, CV preparation (differences between Bio-Data, CV and Resume), LinkedIN profile and Digitizing career Portfolio Common Errors in Writing: describing a process, Statement of Purpose, Instructions, Checklists. 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.	11
	Total Hours	36

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.

Course Code	Course Name	L	T	P	Credit	Year of Introduction
ES0U10H	Introduction to Python	2	0	0	2	2022

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 data processing in Python and introduces 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	Familiarize the fundamental concepts in Python	Understand
CO 2	Illustrate uses of conditional statements and iterative statements in Python	Apply
CO 3	Develop programs by utilizing the modules Lists, Tuples, Sets and Dictionaries in Python	Apply
CO 4	Develop programs by using user defined functions	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. 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 andcorrecting syntax errors.	5
II	Control statements - Selection structure (if-else, switch-case). Iteration structure (for, while), Testing the control statements.. Strings and Regular Expressions.	5

III	Lists - Basic list Operations and Methods, List of lists, Slicing, Searching and sorting list, List comprehension. Work with tuples. Sets. Work with dates and times. Dictionaries – Dictionary Methods, dictionary literals, adding and removing keys, accessing and replacing values, traversing dictionaries.	7
IV	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.	6
V	NumPy - Basics, creating arrays, Arithmetic, Slicing, Matrix Operations, Random numbers. Visualization: using Matplotlib - Basic plot, Ticks, Labels, and Legends. Working with CSV files with Pandas - Reading, Manipulating, and Processing Data.	7
	Total Hours	**30**

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CY0U18A	ENGINEERING CHEMISTRY LAB	BSC	0	0	2	1	2022

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	Use volumetric titration techniques for quantitative analysis of water.	Apply
CO 2	Use spectroscopic techniques for analyzing and interpreting the IR spectra and NMR spectra of some organic compounds.	Apply
CO 3	Use instrumental techniques for quantitative chemical analysis.	Apply
CO 4	Organize scientific experiments as a team to analyze the results of such experiments.	Analyze
CO 5	Interpret experimental data by themselves to apply them to real world problems.	Analyze

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) MohapatraR. K., *Engineering Chemistry with Laboratory Experiments*, PHILearning, New Delhi, 1stEdition, 2015.

2) George S . C., JoseR., *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.

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
ES0U18B	ELECTRICAL AND ELECTRONICS WORKSHOP	ESC	0	0	2	1	2022

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 forthe Practical Electrical Manual*, McGraw-Hill, 9th Edition, 2002.
3) NavasK A, *Electronics Lab Manual*, Volume 1, PHI Learning Private Limited, 5thEdition, 2015.

SEMESTER III

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20G	Discrete Mathematical Structures	BSC	3	1	0	4	2022

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 and fundamental concepts in Graph Theory eventually in practical applications.

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COURSE OUTCOMES

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

Course Outcomes	Description	Learning Level
CO 1	Use the truth tables, deductive reasoning and inference theory on Propositional Logic check the validity of predicates in Propositional and Quantified Propositional Logic	Apply
CO 2	Classify binary relations into various types and Illustrate an application for Partially Ordered Sets and Complete Lattices	Apply
CO 3	Describe the fundamentals of abstract algebraic systems - Semigroups, Monoids, Groups, Homomorphism and Isomorphism of Monoids and Groups	Understand
CO 4	Explain vertices and their properties, types of paths, classification of graphs, trees, Planar graphs & their properties.	Apply
CO 5	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring	Apply

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.
Linear recurrence relations with constant coefficients – homogeneous, non-homogeneous Solution. Principles of counting.

Binary Relation and Functions. - Relations, Equivalence Relations and partitions. Partial Order relations, partially ordered Set - Lattice, Properties of Lattice.

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.

Introduction to Graphs, Definition, incidence and degree, sub graphs walks, paths, circuits, Isomorphism, Connectedness, Eulerian and Hamiltonian graphs, Travelling salesman problem, Fleury’s algorithm

Matrix representation of graphs, Trees, basic properties of trees, Binary trees, Spanning and Minimal spanning tree, Dijkstra, prims and Kruskal algorithms

Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties, Planarity of graphs, Kurtowski's two graphs, Euler's formula, Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm

TEXT BOOKS

1. Discrete and Combinatorial Mathematics (An Applied Introduction), Ralph P Grimaldi, B V Ramana , 5th Edition, Pearson
2. Narsingh Deo, Graph theory, PHI,1979

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
4. Douglas B. West, Introduction to Graph Theory, Prentice Hall India Ltd.,2001
5. J.A. Bondy and U.S.R. Murty. Graph theory with Applications
6. Robin J. Wilson, Introduction to Graph Theory, Longman Group Ltd.,2010

COURSE PLAN

Module	Contents	No. of hours
I	**Mathematical logic**, Basic Connectives and Truth Table Statements, 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,The use of Quantifiers, Open Statement, Quantifier, Negation **Linear Recurrence Relations** with Constant Coefficients of order one and two-Homogeneous Solution Non homogeneous Solution. Pigeonhole principle, Principle of inclusion and exclusion, derangements.	12
II	**Binary Relation**-Reflexive Relations, Symmetric Relations, Transitive relations, Antisymmetric Relations-Partial Order relations Equivalence Relation, Equivalence Classes Partitions, Irreflexive Relations. Partially ordered Set, Hasse Diagram Maximal-Minimal Element, Least Upper bound, Greatest Lower Bound, **Lattice**- Dual Lattice, sub lattice , Properties of glb and lub Properties of Lattice , Special Lattice , Complete Lattice,Bounded Lattice, Complemented Lattice, Distributive Lattice	12
III	**Algebraic Systems**-Binary operations on a set and its properties Semi group , Monoid, Sub semigroup and sub monoid Cyclic 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
IV	**Concepts of Graphs and Trees**: Definition, incidence and degree, sub graphs walks, paths, circuits, Isomorphism, Connectedness, Eulerian and	12

	Hamiltonian graphs, Travelling salesman problem, Fleury's algorithm Matrix representation of graphs, adjacency and incidence matrix Trees, basic properties of trees, Binary trees Spanning and Minimal spanning tree Graph theoretical algorithms: Dijkstra, prims and Kruskal	
V	**Connectivity and Planar Graphs** Vertex Connectivity, Edge Connectivity, Cut set and Cut vertices, Fundamental circuits, Planar graphs and their properties: Planarity of graphs, Kurtowski's two graphs, Euler's formula, **Coloring-** Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.	**12**
	Total hours	**60**

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**

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 counter, BCD counter.	12
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

Course Code	Course Name	L	T	P	Credit	Year of Introduction
CS2U20A	Object oriented Programming using Python	3	1	0	4	2022

PREREQUISITE: ES0U10H INTRODUCTION TO PYTHON

COURSE OVERVIEW:

Aim of the course is to introduce Object oriented concepts in programming. The course covers Object Oriented Principles, Object Oriented Programming in Python, 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 Python.

COURSE OUTCOMES

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

CO1	Construct Object Oriented Design using Unified Modelling Language (UML)	Apply
CO2	Apply the object-oriented concepts - classes, objects, constructors, inheritance, and polymorphism to write python programs.	Apply
CO3	Utilize packages, modules, files, and exception handling mechanism to develop programs	Apply
CO4	Utilize multithreading and database connectivity to develop Python applications.	Apply
CO5	Apply event driven programming and tkinter to develop Graphical User Interface based python 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.

Object Oriented Programming in Python - Class Fundamentals, Constructors, Method Overloading, Access Control, Inheritance - Method Overriding, Accessors and Mutators.

Modules and Packages, Exception Handling, Input/ Output - Reading Console Input, Writing

Console Output. Working with Files. Multithreaded Programming.

tkinter fundamentals - Model View Controller (MVC), Event Handling in tkinter, Exploring tkinter, Database Connectivity in Python.

TEXT BOOKS

1) Blaha, "Object - Oriented Modeling and Design With Uml", 2/E, Pearson Education,2nd Edition,2007

2) Python Object Oriented Programming, Steven F Lott, Dusty Phillips, 4/e, Packt Publishing, June 2021

3) Michael H. Goldwasser, David Letscher, "Object Oriented Programming in Python," Prentice Hall, 1st Edition, 2007.

4) Mark Lutz "Programming Python," O'Reilly 4th Edition,2010

REFERENCES

1) Kenneth A Lambert., Fundamentals of Python: First Programs2/e, Cengage Publishing, 2016

2) Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016

COURSE PLAN

Module	Contents	No. of hours
I	**Approaches to Software Design** - Functional Oriented Design, Object Oriented Design, Object Modeling Using Unified Modeling Language (UML), UML diagrams, Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram. Case study. **Introduction to Object Oriented concepts** – Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism.	10
II	**Object Oriented Programming in Python** - Class Fundamentals, Class attributes, Class decorators, Declaring Objects, Instance attributes, Introduction to Methods, static methods, Constructors, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Accessors and Mutators, Inner Classes. Inheritance, Avoiding Inheritance, Calling Order of Constructors, Method Overloading, Operator Overloading, Method Overriding, Overriding magic methods, Abstract Classes, and Methods.	14
III	**More features of Python**: Modules & Packages- Defining Package, Modular Programming, Importing Packages, Python PIP Packages, Date and Time package. Mathematical functions: math, Python sys, os modules **Exception Handling-** Errors in Python Program, Types of	14

	Exceptions, Try and Except Statement- Catching Exceptions, Multiple catch Clauses, nested try Statements, Exception hierarchy, user defined exceptions, finally. Assertions in Python, Try with Else Clause. **Input/ Output** - command-line parameters, File handling in Python.	
IV	**Multithreaded Programming** - The Python Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	8
V	**Graphical User Interfaces** – Event-driven programming, Coding simple GUI-based programs: Canvas, Labels, displaying images, Input text entry, Popup dialog boxes, Command buttons, tkinter fundamentals - tkinter Key Features, Model View Controller (MVC), tkinter Packages, Event Handling in tkinter, exploring tkinter –Widgets- Basic Widgets, Top level Widgets, Geometry Management, Binding Functions Working with Images in Tkinter. **Database connectivity in Python**. -Creating and Executing Queries – create table, delete, insert, select.	14
		Total hours: 60

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, New Delhi, 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, New Delhi,2014.
2. Charles D Fledder mann, 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

Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
NC0U20**B**	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 to certain classes, amendments to constitution.	6
	Total hours	30

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, SartajSahni 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**

Course Code	Course Name	L	T	P	Credit	Year of Introduction
CS2U28A	Object oriented Programming Lab (in Python)	0	0	3	2	2022

PREREQUISITE: ES0U10H : Introduction to Python

COURSE OVERVIEW:

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

COURSE OUTCOMES

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

CO 1	Implement programs in Python which use data types, operators, control statements, functions, lists and dictionaries	Apply
CO 2	Implement the Object-Oriented concepts - inheritance, polymorphism in Python	Apply
CO 3	Implement robust application programs in Python using exception handling and Files.	Apply
CO 4	Implement application programs in Python using multithreading ..	Apply
CO 5	Implement Graphical User Interface based application programs by utilizing event handling features and tkinter in Python.	Apply

SYLLABUS

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

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

Sl .No.	**Topics**	**No. of hours**
I	Basic programs using data structures, operators, and control statements and functions	6
II	Program to implement object oriented concepts.	9
III	Program using File Handling & Exception handling.	6
IV	Program using multi-threading applications	9
V	Graphical user Interface using tkinter	9
VI	Miniproject	6
		Total hours:45

SEMESTER IV

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
MA0U20F	Mathematics for Artificial Intelligence	BSC	3	1	0	4	2022

COURSE OVERVIEW: 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, 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 and debug existing ones, and learn about the inherent assumptions and 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 and eigenvectors to solve computational problems	Apply
CO2	Apply concepts of orthogonality and matrix decompositions to solve Engineering problems	Apply
CO 3	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients	Apply
CO 4	Utilize the concepts, rules and results about probability and Bayes' theorem to find solutions of computational problems	Apply
CO 5	Use unconstrained and constrained optimization methods in machine learning problems	Apply

SYLLABUS

Systems of Linear Equations, vector spaces, Linear mappings, Orthogonality, Matrix Decompositions: Norms, Eigen decomposition and Diagonalization, Singular Value Decomposition, differentiation of Univariate Functions, Useful Identities for Computing Gradients**,** Concepts of probability, Baye's theorem**,** correlation, Independence, 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	**ORTHOGONALITY and 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.	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, Conditional probability and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution –Linear Correlation-Curve fitting-Co variance matrix-independence.	12
V	**Optimization :** Optimization Using Gradient Descent - Gradient Descent With Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming	10
Total hours (Approx.)		60

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**

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

PRE-REQUISITE: MA0U20B Discrete 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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U20B	Introduction to Artificial Intelligence	PCC	3	1	0	4	2022

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 tounderstand 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.

PRE-REQUISITE: NIL

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

CO 1	Explain the fundamental concepts of intelligent systems and their architecture.	Understand
CO 2	Illustrate uninformed and informed search techniques for problem solving inintelligent systems.	Understand
CO 3	Solve Constraint Satisfaction Problems using search techniques.	Apply
CO 4	Represent AI domain knowledge using logic systems and use inference techniques for reasoning in intelligent systems.	Apply
CO 5	Illustrate different types of learning techniques used in intelligent systems	Apply

SYLLABUS

Module – 1 (Introduction)

Introduction – What is Artificial Intelligence(AI) ? The Foundations of AI, History of AI, Applications of AI. Intelligent Agents – Agents and Environments, Good behavior: The concept of rationality, Nature of Environments - Specifying the task environment, Properties of task environments. Structure of Agents - Agent programs, Basic kinds of agent programs.

Module – 2 (Problem Solving)

Solving Problems by searching-Problem solving Agents, Example problems, Searching for solutions, Uninformed search strategies, Informed search strategies, Heuristic functions.

Module - 3 (Search in Complex environments)

Adversarial search - Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems – Defining CSP, Example Problems, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, Structure of CSP problems.

Module - 4 (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, Using First Order Logic, Knowledge representation in First Order Logic. Inference in First Order Logic – Propositional Vs First Order inference, Unificationand Lifting, Forward chaining, Backward chaining, Resolution. Classical Planning - Algorithms for planning state space search, Planning Graphs.

Module - 5 (Machine Learning)

Learning from Examples – Forms of Learning, Supervised Learning. Learning Decision Trees- The decision tree representation, Inducing decision trees from examples, Choosing attribute tests, Generaliztion and overfitting. Evaluating and choosing the best hypothesis, Regression and classification with Linear models.

TEXT BOOK

1. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, 3rd Edition. Prentice Hall.

REFERENCES

1. Nilsson N.J., Artificial Intelligence - A New Synthesis, Harcourt Asia Pvt. Ltd.

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- - Specifying the task environment, The structure of Agents - Agent programs, Basic kinds of agent programs	9
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	7

III	Adversarial search – Games, Optimal decisions in games, The Minimax algorithm, Alpha-Beta pruning, Constraint Satisfaction Problems – Defining CSP, Example Problem formulations, Constraint Propagation- inference in CSPs, Backtracking search for CSPs, The structure of problems	8
IV	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, Classical Planning, Algorithms for planning state space search, Planning Graphs .	12
V	Learning from Examples – Forms of Learning, Supervised Learning, Learning Decision Trees- The decision tree representation, Inducing decision trees from examples, Choosing attribute tests, Generaliztion and overfitting, Evaluating and choosing the best hypothesis, Regression and classification with Linear models.	8

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

1) Clive L Dym, *Engineering Design: A Project Based Introduction*, Fourth Edition, John Wiley & Sons, New York 2009.
2) Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business; Revised, Updated ed. edition (5 March 2019)
3) Don Norman , *The Design of Everyday Things*, Basic Books; 2 edition (5 November 2013)
4) Dominique Forest , *Art of Things: Product Design Since 1945*, Abbeville Press Inc.,U.S.; Special edition (16 October 2014)
5) Javier Abarca, Al Bedard, et al, *Introductory Engineering Design – A Projects-Based Approach*, 3rd ed, Regents of the University of Colorado, 2000.
6) 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, 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	4
	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.	3

	Modelling, Prototyping and Proof of Concept. Awareness of Basic tools of Design like – Autodesk, CATIA, MATLAB	
	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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
NC0U20C	UNVERSAL HUMAN VALUES -II	MNC	2	1	0	3	2022

COURSE OVERVIEW:
The objectives of the course are:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS'
2. To facilitate the development of a Holistic perspective among students towards life and profession leading towards a value-based living
3. To help the students to have ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with nature.

PRE-REQUISITE: None. Universal Human Values 1 (Desirable)

COURSE OUTCOMES

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

CO 1	Explain more of themselves and their surroundings (family, society, nature)	Understand
CO 2	Show more responsibility in life to handle problems with sustainable solutions keeping human relationships and human nature in mind	Understand
CO3	Demonstrate more Commitment towards human values, human relationship and human society	Understand
CO 4	Apply what they have learnt about Harmony to their real life	Apply

SYLLABUS

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

Purpose and motivation for the course, recapitulation from Universal Human Values-I

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration

Continuous Happiness and Prosperity- A look at basic Human Aspirations

Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority

Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

(Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking)

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility

Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)

Understanding the characteristics and activities of 'I' and harmony in 'I'

Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail

Programs to ensure Sanyam and Health.

(Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease)

Module 3: Understanding Harmony in the Family and Society- Harmony in Human Relationship

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness;

Trust and Respect as the foundational values of relationship

Understanding the meaning of Trust; Difference between intention and competence

Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals

Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

(Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives)

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

Understanding the harmony in the Nature

Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self regulation in nature

Understanding Existence as Co-existence of mutually interacting units in all pervasive space

Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values

Definitiveness of Ethical Human Conduct

Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,

c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems

Strategy for transition from the present state to Universal Human Order

a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers.

b. At the level of society: as mutually enriching institutions and organizations

Sum up.

(Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg.To discuss the conduct as an engineer or scientist etc.)

TEXT BOOKS

1) Gaur P.R, Asthana R, Bagaria G.P, Human Values and Professional Ethics (2nd revised Edition) Excel Books, New Delhi, 2019
2) Tripathi A. N, Human Values, New Age Intl. Publishers, New Delhi, 2004.

REFERENCES

1) Gaur R.R, Sangal R, Bagaria G P 'A Foundation Course in Human Values and Professional Ethics (Teacher Manual), Excel Books, 1st Edition 2013.
2) Parichaya E K, Nagaraj A, Jeevan Vidya, Jeevan Vidya Prakashan, Amarkantak, 1999.
3) Mohandas K Gandhi, 'The story of my Experiments with Truth' Fingerprint, 2009
4) Cecile Andrews 'Slow is Beautiful', New Society Publishers, 2006.
5) Kumarappa J C Economy of Permanence, Sarva Seva Sangh Prakashan, 2017.

COURSE PLAN

Each Lecture hour and Tutorial hour can be structured as given below for the efficient delivery of the course content.

MODULE	CONTENT	No.of Hours

I	Understanding Value Education, Self-Exploration as the process for Value Education, Sharing about oneself, Understanding Happiness and Prosperity-the Basic Human Aspirations, Right Understanding, Relationship, Physical Facility, Exploring Human Consciousness, Happiness and Prosperity- Current Scenario, Method to Fulfil the Basic Human Aspirations, Exploring Natural Acceptance	9
II	Understanding Human Being as the Co-existence of the Self and Body, distinguishing between the needs of the Self and the Body, Exploring the difference of needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Exploring Sources of Imagination in the Self, Harmony of the Self with the Body, Programme to ensure Self-Regulation and Health, Exploring Harmony of Self with the Body.	9
III	Harmony in the Family-the Basic unit of Human Interaction, Values in the Human-to-Human Relationship, ‘Trust’ –the foundation Value in Relationship, Exploring the feeling of Trust, ‘Respect’- as the Right Evaluation, Exploring the feeling of Respect, Understanding Harmony in the Society, Vision for the Universal Human Order, Exploring Systems to fulfil Human Goal	9
IV	Understanding Harmony in the Nature, Interconnectedness, self-regulation, and Mutual Fulfilment among the four orders of Nature, Exploring the four orders of Nature, Realizing Existence as Co-Existence at all Levels, The Holistic Perception of Harmony in Existence, Exploring Co-Existence in Existence	6
V	Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, Exploring Ethical Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Exploring Humanistic Models in Education, Holistic Technologies, Production Systems and Management-Models- Typical Case Studies, Strategies for Transition towards Value –based Life and Profession, Exploring Steps of Transition towards Universal Human Order	9

Course Code	**Course Name**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
CS2U28B	AI Algorithms Lab	PCC	0	0	3	3	2022

COURSE OVERVIEW: This laboratory course enables the students to get the fundamental concepts in the area of Artificial Intelligence. This course covers the AI based Algorithms, logical reasoning agents andimplementation of these reasoning systems using either backward or forward inferencemechanisms. This course helps the learners to apply AI techniques to solve real world problems.

PRE-REQUISITE: A sound knowledge of the basics of programming, Discrete Mathematics.

COURSE OUTCOMES:

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

CO 1	State the basics of learning problems with hypothesis and version spaces	Understand
CO 2	Demonstrate real-world problems as state space problems, optimization problems orconstraint satisfaction problems.	Apply
CO 3	Simulate given problem scenario and analyze its performance.	Apply
CO 4	Develop programming solutions for given problem scenario.	Apply
CO 5	Design and develop an expert system by using appropriate tools and techniques.	Apply

SYLLABUS

***Mandatory**

1. Installation and working on various AI tools viz. Python, R, GATE, NLTK, MATLAB etc.*****
2. Implement basic search strategies for selected AI applications*****.
3. Implement state space search algorithms*****
4. Implement informed search algorithms*****
5. Implement backtracking algorithms for CSP*****
6. Implement local search algorithms for CSP*****
7. Implement propositional logic inferences for AI tasks*****
8. Implementation of Knowledge representation schemes*****
9. Implement travelling salesman problem*****
10. Implementation of Game playing (adversarial search)

11. Mini Project that implement a real world application using AI techniques (Group projectwith a maximum of four students)

References:

1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third edition, Pearson Edition, 2006
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/)
5. Artificial Intelligence by Example: Develop machine intelligence from scratch usingreal artificial intelligence use cases -by Dennis Rothman, 2018
6. Padhy, N.P. 2009. Artificial Intelligence and Intelligent Systems, Oxford UniversityPress
7. Brachman, R. and Levesque, H. 2004. Knowledge Representation and Reasoning, Morgan Kaufmann.

CS1U28E	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.	Apply
CO2	Construct queries using SQL for database creation, interaction, modification, and Updation.	Apply
C03	Design and implement triggers and cursors.	Apply
C04	Implement procedures, functions, and control structures using PL/SQL**.**	Apply
CO5	Perform CRUD operations in NoSQL Databases	Apply
C06	Develop database applications using front-end tools and back-end DBMS.	Apply

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**.

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.

B.Tech (MINOR)

Minor Basket I: Software Engineering

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS0M20A	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, ObjectOriented 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*, 4thedition, PHI,2014.
3) Paul Deitel, Harvey Deitel, *Java How to Program*, Early Objects 11thEdition, 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-LineArguments, 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 – ArrayList. 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

Course Code	Course Name	Categor y	L	T	P	Credi t	Year of Introductio n
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 indeveloping 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 ObjectOriented 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**

Minor Basket 2: Artificial Intelligence & 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 skillsto 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 removingkeys, 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**

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 ComputerScience 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

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**

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 ShortestPath 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**

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	2022

PRE-REQUISITE: NIL

COURSE OVERVIEW: The aim of this course is to create awareness among learners about theimportant 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 goalof 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'sAlgorithm, 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 orderingPrinciple, 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 modulop, Pseudo-primes and Carmichael numbers, Solvingcongruences modulo prime powers. Euler's Function-Euler's Totient function, Applications of Euler'sTotient 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
	Totalhours (Approx.)	**60**

Honour Bucket 2: COMPUTATIONAL BIOLOGY

CS2H20A	**COMPUTATIONAL FUNDAMENTALS FOR BIOINFORMATICS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2022**

PRE-REQUISITE: Basic understanding of programming languages.

COURSE OVERVIEW: Bioinformatics is an interdisciplinary area that combines Computer Science, Molecular Biology, and Mathematics and allied areas of Science. This course covers computational fundamentals of Bioinformatics and Computational Biology such as DNA, genes and proteins, transcription, translation, sequence alignment, representation and basic Python programming required for handling bioinformatics data. The learners will be able to solve basic bioinformatics problems using python programming.

COURSE OUTCOMES

CO 1	Describe the basic concepts of Bioinformatics with an emphasis on biologicalmacromolecules-DNA, RNA and Protein and synthesis of biomolecules	Understand
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio-sequences to identify similarity, dynamic programming.	Apply
CO 3	Illustrate nucleotide attributes and transcription using programming tools	Apply
CO 4	Demonstrate the concepts of Parsing FASTA and Sequences Analysis	Apply
CO 5	Compute k-mers, translation of DNA subsequences and Open reading frame.	Apply

SYLLABUS

Module-1 (**Introduction to bioinformatics**)

Introduction to bioinformatics, Nature & Scope of Bioinformatics, animal vs plants, Eukaryote vs prokaryote, Nucleus. Chromosome, gene DNA, RNA, amino acids, and Protein, The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure, Transcription,translation.

Module-2 (Introduction to bio sequences and analysis)

Introduction to Biological Databases and data storage, NCBI, Genbank, Bio sequence formats-Database Similarity Searching, BLAST, Sequence alignment, Scoring Matrices, Multiple-Sequence Alignment, Dynamic programming

Module 3: (Introduction to Processing Nucleotides)

Tetranucleotide Frequency, Counting the Nucleotides, Writing and Verifying a Solution, Transcribing DNA into mRNA: Mutating Strings, Reading and Writing Files, Reverse Complement of DNA, String Manipulation, Iterating Over a Reversed String.

Module 4: (Processing Nucleotides GC Content and Hamming Distance)

Creating the Fibonacci Sequence, Writing, Testing, and Benchmarking Algorithms, retrieving FASTA Using Bio python, Iterating the Sequences Using a for Loop, Parsing FASTA and Analyzing Sequences, Computing GC Content, Finding the Hamming Distance, Counting Point Mutations

Module 5 (Translation of DNA and subsequence)

K-mers and Codons, Translating Codons, Translating mRNA into Protein, Finding Subsequences of DNA, Find a Motif in DNA, Finding Overlapping Patterns Using Regular Expressions, Sequence Similarity, Finding the Shortest Sequence in a FASTA File, Extracting K-mers from a Sequence, Counting Frequencies of K-mers, Finding Open Reading Frames

TEXT BOOKS

1. Mount, D. W.. Bioinformatics: Sequence and Genome Analysis. India, CBS Publishers& Distributors, 2005.
2. Youens-Clark, Ken. *Mastering Python for Bioinformatics*. United States: O'ReillyMedia, 2021.

REFERENCES

1. Kelley, S.T. and Didulo, D, *Computational Biology: A Hypertextbook*. John Wiley & Sons,2020
2. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. JohnWiley & Sons, 2020.
3. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I.* Springer, 2019
4. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics*. *An introduction–Springer*, *Verlag*,, 2008.
5. S C Rastogi, N Mendiratta and P Rastogi, *Bioinformatics: Methods and Applications*, PHILearning Private Limited, New Delhi, 2015.
6. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education,2006.
7. Bassi, Sebastian. *Python for Bioinformatics*. United Kingdom: CRC Press, 2017.

8. Model, Mitchell L. Bioinformatics Programming Using Python. United States: O'Reilly Media, 2010.
9. Antao, Tiago. *Bioinformatics with Python Cookbook*. United Kingdom: Packt Publishing, 2015.Antao, Tiago. Bioinformatics with Python Cookbook: Learn how to Use Modern Python Bioinformatics Libraries and Applications to Do Cutting-edge Research in Computational Biology, 2nd Edition. United Kingdom: Packt Publishing, 2018.

COURSE PLAN

Module	Contents	No. of hours
I	Introduction to bioinformatics, Nature & Scope of Bioinformatics, Animal vs plants, Eukaryote vs prokaryote, Nucleus. Chromosome, gene, DNA, RNA, and Protein, The Central Dogma introduction, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, Translation,	10
II	Introduction to Biological Databases and data storage, NCBI, Genbank, NCBI, Genbank Sequence retrieval, Bio sequence formats, Database Similarity Searching, BLAST, BLAST Exercises, Sequence alignment, Scoring Matrices, Multiple-Sequence Alignment, Introduction to Dynamic programming in MSA.	10
III	Counting the Nucleotides, Writing and Verifying a Solution, Transcribing DNA into mRNA, Iterating the Input Files, Mutating Strings, Writing and Reading Output Sequences, Reverse Complement of DNA, String Manipulation, Iterating Over a Reversed String	10
IV	Creating the Fibonacci Sequence, Writing, Testing, and Benchmarking Algorithms, Retrieving FASTA Using Biopython, Parsing FASTA and Analysing Sequences, Computing GC Content, Finding the Hamming Distance, Iterating the Characters of Two Strings, Counting Point Mutations	8
V	K-mers and Codons, Translating mRNA into Protein, Finding Subsequence of DNA, Find a Motif in DNA, Finding Overlapping Patterns Using Regular Expressions, Sequence Similarity, Finding the Shortest Sequence in a FASTA File , Extracting K-mers from a Sequence, Counting Frequencies of K-mers, Finding Open Reading Frames	9

Honour Bucket 3: COMPUTER VISION

CS2H20B	**ADVANCED TOPICS IN COMPUTER GRAPHICS**	**CATEGORY**	**L**	**T**	**P**	**CREDITS**
		VAC	**3**	**1**	**0**	**4**

PREREQUISITE: A sound knowledge of Mathematics and concepts of any programming language.

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, basic mathematical techniques and algorithms used to build useful applications. This course enables the learners to develop the ability to create image processing frameworks for different domains and develops algorithms for emerging displaytechnologies.

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

CO 1	Describe the working principles of graphics devices	Understand
CO 2	Illustrate line drawing, circle drawing and polygon filling algorithms	Apply
CO 3	Demonstrate geometric representations and transformations on 2D & 3D objects.	Apply
CO 4	Demonstrate the working of various clipping algorithms and projection algorithms.	Apply
CO 5	Summarize visible surface detection methods	Understand
CO6	Explain the concept of realism in a scene and its performance preservation	Understand

SYLLABUS

Module – 1(Line and Circle drawing algorithms)

Basics of Computer Graphics and its applications. Video Display devices - Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays, Flat panel display and its categories. Line drawing algorithms - DDA, Bresenham's algorithm. Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's algorithm.

Module - 2(Filled Area Primitives and Two dimensional transformations)

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.

Module - 3 (Clipping and 3D transformations)

Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. Three dimensional viewing pipeline. Basic 3D transformations.

Module - 4 (Projections and Visible Surface detection)

Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

Module - 5 (Realism and performance)

Realism - Illumination Shading, Shadows, Texture mapping, Bump mapping, Environment mapping, Transparency, Accumulation Buffer, Back face Culling, Visibility Culling.

TEXT BOOKS

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Aditi Majumder and M.Gopi , Introduction to VISUAL COMPUTING Core Concepts in Computer Vision, Graphics, and Image Processing, 2018

REFERENCES

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) Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL, PHI, 4e, 2013.

COURSE PLAN

Module	**Contents**	**No. of hours**
I	Basics of Computer Graphics and applications, Refresh Cathode Ray Tubes, Random and Raster Scan Displays and systems, Color CRT displays, Flat panel display and its categories, DDA Line drawing Algorithm, Bresenham's line drawing algorithm, Midpoint Circle generation algorithm, Bresenham's Circle generation algorithm, Illustration of line and circle drawing algorithms	10
II	Scan line polygon filling, Boundary filling and flood filling, Basic 2D transformations-Translation, Basic 2D transformations-Rotation, Basic 2D transformations- Scaling, Reflection and Shearing, Illustration of Basic 2D Transformations, Composite transformations, Matrix representations and homogeneous coordinates	9

III	Window to viewport transformation, Cohen Sutherland Line clipping algorithm, Midpoint subdivision Line clipping algorithm, Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon clipping algorithm, Three-dimensional viewing pipeline, Basic 3D transformation-Translation and scaling, Basic 3D transformation-Rotation	8
IV	Projections-Parallel projections, Projections- Perspective projections, Illustration of projection methods, Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line visible surface detection algorithm, *A buffer* algorithm,	7
V	Illumination, Shading and Shadows, Texture mapping-Texture to object space mapping, Texture mapping-Object to screen space mapping and Mip Mapping, Bump mapping, Bump mapping-Illustration, Environment mapping and Transparency, Accumulation Buffer and Back face Culling, Visibility Culling, Visibility Culling	10

SEMESTER V

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U30A	**Formal Languages and Automata Theory**	**PCC**	**3**	**1**	**0**	**4**	**2022**

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:

Course Outcomes	Description	Level
CO 1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable.	**Understand**
CO 2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation.	**Understand**
CO 3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language	**Apply**
CO 4	Design Turing machines as language acceptors or transducers	**Apply**
CO 5	Explain the notion of decidability.	**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)

REFERENCES

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	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, MyhillNerode 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. Context Sensitive Grammar (CSG), Linear Bounded Automata. (Concept only).	**12**
V	Context Sensitive Languages, Turing Machines Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata.Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.	**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
CS1U30B	**Computer Networks**	**PCC**	**3**	**1**	**0**	**4**	**2022**

COURSE OVERVIEW

The 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 analyze 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:

Course Outcomes	Description	Level
CO 1	Explain the features of computer networks, protocols, and network design models	**Understand**
CO 2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication	**Apply**
CO 3	Explain the design issues of data link layer, link layer protocols, bridges and switches	**Understand**
CO 4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11)	**Understand**
CO 5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network	**Apply**
CO 6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking	**Understand**

SYLLABUS

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

REFERENCES

. 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	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.	**12**
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.	**12**
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**
	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
CS1U30K	**Operating Systems**	**PCC**	**3**	**1**	**0**	**4**	**2022**

PRE-REQUISITE: CS1U20A Data Structures and ES0U10G Problem Solving and Programming 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:

Course Outcomes	Description	Level
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
CS2U30C	**Introduction To Machine Learning**	**PCC**	**3**	**1**	**0**	**4**	**2022**

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.

Prerequisite: ES0U10H Introduction to Python

ii. COURSE OUTCOMES

Course Outcomes	Description	Level
CO1	Illustrate Machine Learning concepts and basics of supervised learning concepts.	Apply
CO2	Illustrate and evaluate supervised learning techniques	Apply
CO3	Solve real life problems using appropriate machine learning models	Apply
CO4	Illustrate basics of parameter estimation models and the working of SVM classifier	Apply
CO5	Demonstrate the use of dimensionality reduction techniques and unsupervised learning concepts	Apply

iii. SYLLABUS

iv (a) TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

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. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.

7. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016

8. 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**	**Hours**
I	Introduction to Machine Learning, Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Classfication, regression and clustering , Basics of parameter estimation - Maximum Likelihood Estimation(MLE) and Maximum a Posteriori estimation(MAP). Bias-Variance decomposition Intel AI tools • Jupyter* Lab for interactive coding • NumPy, SciPy, and pandas for numerical computation • Matplotlib and seaborn for data visualization • Intel optimised library –modin Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method • Scikitlearn	**12**
II	KNN Classifier and Regressor Logistic Regression Model Evaluation-Bias-Variance-tradeoff, Overfitting and under fitting, Cost function Regularization –L1 and L2 DT in regression Bayes theorem, Naive Bayes Classifier Decision tree algorithm ID3, CART Case Study: Develop a classifier for face detection.	**12**
III	Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve AUC. Bootstrapping, Cross Validation. Support Vector Machines - Introduction, Maximum Margin hyperplanes, Mathematics behind Maximum Margin Classification, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF), Kernel Trick.	**12**
IV	Dimensionality reduction – Subset selection, Principal Component Analysis. Unsupervised Learning - Clustering Methods -Similarity measures, K-means clustering Expectation-Maximization for soft clustering, Hierarchical Clustering Methods – Agglomerative and divisive, Density based clustering.	**12**

	Ensemble methods, Voting, Bagging, Boosting.	
V	Association Rule Mining- Apriori algorithm Perceptron, Perceptron Learning, Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU,Tanh), Back Propagation Algorithm, Illustrative Example for Back Propagation	**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
CS2U30D	Artificial Neural Network	PCC	3	1	0	4	2022

COURSE OVERVIEW

This course provides a comprehensive introduction to Artificial Neural Networks, a fundamental concept in the field of machine learning and artificial intelligence. Students will gain a deep understanding of the theoretical foundations, practical applications, and design principles of neural networks.

COURSE OUTCOMES:

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

Course Outcomes	Description	Level
CO 1	Explain the fundamentals of artificial neural networks and their applications.	Understand
CO 2	Apply supervised learning techniques, including Perceptron learning and α-Least Mean Square Learning, to solve practical problems	Apply
CO 3	Implement the Backpropagation algorithm for designing and evaluating multi-layered network architectures.	Apply
CO 4	Explain the architecture and learning techniques of various Attractor Neural Networks	Understand
CO 5	Explain the principles of self-organizing feature maps and their practical applications.	Understand

SYLLABUS

TEXTBOOKS

1. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. Simon Haykin, "Neural Networks: A comprehensive foundation", Second Edition, Pearson Education Asia.
2. Robert J. Schalkoff, "Artificial Neural Networks", McGraw-Hill International Editions, 1997
3. B. Yegnanarayana. "Artificial neural networks"., PHI Learning Pvt. Ltd.

COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Biological Neuron-Artificial Neural Model - Types of activation functions - Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks.	12
II	**Supervised Learning I**: Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNS, Perceptron Learning Algorithm, Perceptron Convergence Theorem. Perceptron learning and Non-Separable sets, α-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, μ-LMS approximate to gradient descent, Application of LMS to Noise Cancellation.	12
III	**Supervised Learning II:** Multi-layered Network Architecture, Backpropagation Learning Algorithm, Practical consideration of BP algorithm, Applications of Feedforward Neural Networks.	12
IV	**Attractor Neural Networks**: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box Neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	12
V	**Self-organization Feature Map**: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self- organization Feature Maps, Application of SOM, Growing Neural Gas.	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

NC0U30A	DISASTER MANAGEMENT	Category	L	T	P	Credit	Year of Introduction
		MNC	2	0	0	Nil	2022

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 andthe measures to reduce disaster risks.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts and terminology related to disaster management cycle	Understand
CO 2	Explain hazard and vulnerability types and disaster riskassessment	Understand
CO 3	Describe the process of risk assessment and appropriatemethodologies to assess risk	Understand
CO 4	Explain the core elements and phases of disaster risk management and measures to reduce disaster risks across sectorand 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 ofIndia,2019.
4. Disaster Management Training Manual, UNDP, 2016
5. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster RiskReduction 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 preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment	6
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 ofdisaster risk management Phases of disaster risk management, Measures for disaster riskreduction Measures for disaster prevention, mitigation, and preparedness Disaster response- objectives, requirements. Disaster responseplanning; 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	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
CS2U38A	Operating Systems and Networking Lab	PCC	0	0	4	2	2022

PRE-REQUISITE: Nil

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:

Course Outcomes	Description	Level
CO 1	Implement Process Creation and Inter Process Communication in Operating Systems.	Apply
CO 2	Implement Process Synchronization algorithms in Operating Systems	Apply
CO 3	Implement modules for Deadlock Detection and Deadlock Avoidance in Operating Systems.	Apply
CO 4	Implement Medium Access Protocols	Apply
CO 5	Implement Transport Layer Protocols	Apply
CO 6	Implement Remote Procedure Calls	Apply

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	Implement programs for Inter Process Communication using PIPE, Message Queue and Shared Memory.	8

2	Write a program to simulate the working of the dining philosopher's problem.	8
3	Implement the banker's algorithm for deadlock avoidance.	8
4	Software simulation of Medium Access Control Protocols- 1) Go Back N 2) Selective Repeat and 3) Sliding Window	9
5	Implementation of a subset of simple mail transfer protocol using UDP	9
6	Implementation of a subset of a file transfer protocol using TCP/IP	9
7	Implementation of Remote Procedure Call (RPC)	9
	Total	**60**

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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U38B	Machine Learning Lab	PCC	0	0	4	2	2022

COURSE OVERVIEW:

This course enables the learners to get hands-on experience in most popular supervised learning algorithms (such as linear regression, logistic regression, decision trees, Bayesian learning and Naive Bayes algorithm) and unsupervised learning algorithms (such as basic clustering algorithms). This helps the learners to understand the process of knowledge inference from raw data through dataset preprocessing and analysis.

Prerequisite: Fundamentals of Programming, Python programming fundamentals, Machine learning.

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COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Implement machine learning algorithms using packages and libraries in Python for various applications	Apply
CO 2	Implement python programs for supervised learning methods through Neural network, Regression, and classification	Apply
CO 3	Implement clustering algorithms.	Apply
CO 4	Apply dimensionality reduction as a dataset preprocessing step.	Apply

TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

COURSE PLAN

SL No.	Topics	No. of hours
	Pandas ,Numpy and Visualization tools	20
1.	Implement K-Nearest Neighbor algorithm to classify any dataset	4
2.	Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy.	4
3.	Implement a Python program to perform logistic regression on a dataset.	4
4.	Write a Python program to implement Naive Bayes classifier and calculate the accuracy, precision, and recall for your data set.	4
5.	Write a Python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	4
6.	Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.	4
7.	Implement dimensionality reduction using PCA.	4
8.	Implement K-Means Clustering using any given dataset.	4
9.	Implement Agglomerative Hierarchical Clustering.	4
10.	Build an Artificial Neural Network using Backpropagation algorithm and test the same with appropriate dataset.	4
	Total	60

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

Minor Basket 1: SOFTWARE ENGINEERING

Course Code	Course Name	Category	L	T	P		Credit		Year of Introduction
CS0M30A	**Concepts In Software Engineering**	**VAC**	**3**	**1**	**0**		**4**		**2022**

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.

Prerequisite: Basic understanding of Object Oriented Design and Development.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Differentiate Traditional and Agile Software Development approaches	Understand
CO 2	Prepare Software Requirement **Specification** and Software Design for a given problem.	Apply
CO 3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project	Apply
CO 4	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.	Apply
CO 5	Utilize SQA practices, Process Improvement techniques and Technology improvements namely cloud based software model and containers & microservices in a Software Development Process.	Apply

SYLLABUS

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.

Functional and non-functional requirements, Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions".

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.

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

Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks

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.

REFERENCES

1. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
2. StarUML documentation - https://docs.staruml.io/
3. OpenProject documentation - https://docs.openproject.org/
4. BugZilla documentation - https://www.bugzilla.org/docs/
5. GitHub documentation - https://guides.github.com/
6. Jira documentation - https://www.atlassian.com/software/jira

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Software Engineering:** 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.	12
II	**Requirement Analysis and Design:** 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	12

	as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure**.**	
III	**Implementation and Testing:** 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.	**12**
IV	**Software Project Management:** 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 and Process Improvement:** 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.	**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

Minor Basket 2: MACHINE LEARNING

Course Code	Course Name	Category	L	T	P		Credit		Year of Introduction
CS0M30B	**Concepts In Machine Learning**	**VAC**	**3**	**1**	**0**		**4**		**2022**

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.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate Machine Learning concepts and basic parameter estimation methods.	Apply
CO 2	Demonstrate supervised learning concepts (regression, linear classification).	Apply
CO 3	Illustrate the concepts of Multilayer neural network and Support Vector Machine	Apply
CO 4	Describe unsupervised learning concepts and dimensionality reduction techniques.	Apply
CO 5	Solve real life problems using appropriate machine learning models and evaluate the performance measures	Apply

SYLLABUS

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. - Linear regression, Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), 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.
Classification Performance measures

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.

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.

COURSE PLAN

Module	Contents	Hours
I	**Overview of machine learning:** 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.	**12**
II	**Supervised Learning** 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.	**12**
III	**Neural Networks (NN) and Support Vector Machines (SVM)** NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).	**12**
IV	**Unsupervised Learning:** Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation	**12**

	maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	
V	**Classification Assessment:** 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.	**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

Minor Basket 3: Networking

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**.**	Understand
CO 2	Outline the architecture and classifications of client/server systems.	Understand
CO 3	Summarize the client/server network services for an application.	Understand
CO 4	Identify management services and issues in network	Understand
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture	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

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. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.	**13**
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	**12**

	Programming Interface, Database Translator, Network Translator.	

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

Honour Basket 1: Security in Computing

CS1H30A	**CRYPTOGRAPHIC ALGORITHMS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2022**

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.	Understand
CO2	Summarize the classical encryption techniques for information hiding.	Apply
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.	Apply
CO4	Interpret key management techniques for secure communication.	Understand
CO5	Summarize message authentication functions in a secure communication scenario.	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

CS2H30A	Computational Biology	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2022

Honour Basket 2: COMPUTATIONAL BIOLOGY

COURSE OVERVIEW:

This course helps the learners to understand concepts in Genomics, Proteomics Computational Biology, Next Generation Sequencing, NGS Data Analysis and Systems biology. It enables the learners to understand various Next Generation Sequencing Techniques, analysis and interpretation of the NGS Data. Also, course introduces computational and mathematical analysis and modeling of complex biological systems and Systems Biology.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the basic concepts of genomics, microarray, protein structure determination and prediction	**Understand**
CO 2	Explain the fundamental aspects drug discovery and molecular modelling	**Apply**
CO 3	Demonstrate Networks in Biology, types of networks and its representation	**Apply**
CO 4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis	**Understand**
CO 5	Illustrate Next Generation sequence analysis, Mapping approaches and algorithms	**Understand**

SYLLABUS

Genomics and Proteomics, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure, Computer Aided Drug Discovery, Molecular modelling, Computer Aided Drug Discovery, Network Biology, (Next Generation Sequencing and analysis, NGS Data Analysis

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	Genes, Genes in genomes, Genomes of prokaryotes and Eukaryotes, Protein-coding genes, RNA, Single-nucleotide polymorphisms, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure identification, computational methods for protein structure prediction, Homology modelling, Protein folding and fold recognition	**10**
II	Drug discovery pipeline, Drug target identification & validation, Active site identification, pharmacophore, Lead/Ligand identification, lead compound optimization, Binding energy calculation, Energy Minimization. Molecular modelling in drug discovery, concept of Molecular Dynamics, concept of Absorption, Distribution, Metabolism and Excretion (ADME), Quantitative Structure-Activity Relationships	**10**
III	Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein-Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation	**14**
IV	A Typical NGS Experimental Workflow, Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq)	**13**
V	Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms, Selection of Mapping Algorithms and Reference Genome Sequences, SAM/BAM as the Standard Mapping File Format, Mapping File Examination and Operation, Tertiary Analysis	**13**

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

Honour Basket 3: COMPTER VISION

CS2H30B	**Advanced Concepts in Computer Vision**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2022**

COURSE OVERVIEW:

This course enables the learners to understand the advanced concepts in computer vision. The course covers the basics of image processing, imaging geometry, image segmentation, feature extraction, object recognition and classification and common applications of computer vision. This course helps the students to design solutions for complex real-life problems.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate the concepts of image formation and image model.	**Understand**
CO 2	Demonstrate various feature extraction and edge detection techniques.	**Apply**
CO 3	Apply edge-based and region-based image segmentation techniques.	**Apply**
CO 4	Understand and implement image recognition and classification methods.	**Apply**
CO 5	Explain the various applications of computer vision	**Understand**

SYLLABUS

Image Formation and Processing, Fundamentals of Image processing, Feature Extraction, Edges Image Segmentation, Image processing using OpenCV - blending, smoothing, and reshaping. Image Recognition and Classification, Object classification using CNNs, Applications,

TEXT BOOKS

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
3. Francesco Camastra, Alessandro Vinciarelli, "Machine Learning for Audio, Image and Video Analysis: Theory and Applications", Springer 2015.

REFERENCES

1. Reinhard Klette, "Concise Computer Vision: An Introduction into Theory and Algorithms", Springer London, 2014.
2. Olivier Faugeras, "Three-Dimensional Computer Vision", The MIT Press, 1993.

COURSE PLAN

Module	Contents	No. of hours
I	Image formation and Image model- Components of a vision system- Cameras- camera model and camera calibration-Radiometry- Light in space- Light in surface - Sources, shadows and shading. Fundamentals of Image processing: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels	**10**
II	Points and Patches – Feature detectors, feature descriptors, feature matching, feature tracking. Edges – edge detection, edge linking. Lines - Successive approximation, Hough transforms, Vanishing points.	**10**
III	Classification of segmentation techniques, Edge detection, Edge linking, Thresholding, Region growing, Region splitting and merging, Watershed based segmentation. Shadow detection and removal. Image processing using OpenCV - blending, smoothing, and reshaping.	**14**
IV	Shape based object classification, Motion based object classification, Viola Jones Object Detection Framework, Object classification using CNNs, use of RCNN for object classification	**13**
V	Speech and Handwriting Recognition, Automatic Face Recognition, Video Segmentation and Keyframe Extraction, Real-Time Hand Pose Recognition.	**13**

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

Course Code	Course Name	Category	L	T	P		Credit	Year of Introduction
CS2U30E	ROBOTICS AND INTELLIGENT SYSTEM	**PCC**	**3**	**1**	**0**		**4**	**2022**

COURSE OVERVIEW

This course enables the learners to understand the fundamental concepts and algorithms in Robotics and Intelligent systems. The course covers the standard hardware and kinematic concepts for robot design. Standard algorithms for localization, mapping, path planning, navigation and obstacle avoidance, to incorporate intelligence in robots are included in the course. This course helps the students to design robots with intelligence in a real world environment.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concepts of manipulator and mobile robotics.	**Understand**
CO 2	Choose the suitable sensors, actuators and control for robot design.	**Apply**
CO 3	Developing kinematic model of mobile robot and understand robotic vision intelligence.	**Apply**
CO 4	Make use of the localization and mapping methods in robotics	**Apply**
CO 5	Plan the path and navigation of robot by applying artificial intelligence algorithm	**Apply**

SYLLABUS

Introduction to robotics - Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots. Dynamic characteristics. Introduction to End effectors , Ethics in robotics - 3 laws - applications of robots. Sensor classification, Internal sensors-External sensors, Digital, Sensor characteristics. Actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control. Robotic Vision: Camera sensor hardware interfacing. Representation of Transformations, Pure Rotation about an Axis - Combined Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot. Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization Current challenges in map representation. Probabilistic map-based localization, Path Planning and Navigation

TEXT BOOKS

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots ,, MIT Press, USA, 2011
2. Thomas Bräunl - Embedded Robotics,Mobile Robot Design and Applications with Embedded Systems-Springer (2006)
3. S.G. Tzafestas - Introduction to Mobile Robot Control-Elsevier (2014)
4. Francis X. Govers - Artificial Intelligence for Robotics-Packt Publishing (2018)
5. Saeed B. Niku - Introduction to Robotics_ Analysis, Control, Applications

REFERENCES

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005
2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
3. Peter Corke - Robotics, Vision and Control_ Fundamental Algorithms in MATLAB® - Springer-Verlag Berlin Heidelberg (2021)

COURSE PLAN

Module	Contents	Hours
I	Introduction to robotics – Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots . Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	**12**
II	Sensor classification- touch, force, proximity, vision sensors. Internal sensors- Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors – Servos, Hydraulic & pneumatic actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control	**12**
III	Robotic Vision: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame. Basic understanding of Differential-Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot, Degree of freedom and manoeuvrability, Degree of steerability, Degree of mobility - different wheel configurations, holonomic and	**12**

	nonholonomic robots. Omnidirectional Wheeled Mobile Robots	
IV	Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - An error model for odometric position estimation Map Representation - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM - Visual SLAM with a single camera - Graph-based SLAM - Particle filter SLAM - Open challenges in SLAM	**12**
V	Path Planning- Graph search, deterministic graph search - , breadth first search - depth first search- Dijkstra' s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition. Alternatives for navigation - Neural networks - Processing the image - Training the neural network for navigation - Convolutional neural network robot control implementation	**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

CS1U30H	ALGORITHM ANALYSIS AND DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2022

PRE-REQUISITE: ES0U10E Programming in C, CS1U20A Data Structures , 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

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

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
4. 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	11

	Salesman Problem.	
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
	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

CS1U30E	MANAGEMENT OF SOFTWARE SYSTEMS	Category	L	T	P	Credit	Year of Introduction
		PCC	3	0	0	3	2022

PRE-REQUISITE: CS2U20A Object Oriented Programming using Python.

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

Course Outcomes	Description	Level
CO1	Demonstrate Traditional and Agile Software Development approaches	Apply

CO2	Prepare Software Requirement Specification and Software Design for a given problem.	**Apply**
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project.	**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**.**	**Apply**
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices.	**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.

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 (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.	**11**

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**
	Total Hours	**45**

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.)

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	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	**11**

	Budgeting - Methods of Investment analysis - Pay back, ARR, NPV, IRR and B/C ratio	
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

SEMESTER V

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS1U30A	Formal Languages and Automata Theory	PCC	3	1	0	4	2022

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:

Course Outcomes	Description	Level
CO 1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable.	**Understand**
CO 2	Explain a formal representation of a given regular language as a finite state automaton, regular grammar, regular expression and Myhill-Nerode relation.	**Understand**
CO 3	Design a Pushdown Automaton and a Context-Free Grammar for a given context-free language	**Apply**
CO 4	Design Turing machines as language acceptors or transducers	**Apply**
CO 5	Explain the notion of decidability.	**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)

REFERENCES

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	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, MyhillNerode 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. Context Sensitive Grammar (CSG), Linear Bounded Automata. (Concept only).	12
V	Context Sensitive Languages, Turing Machines Context Sensitive Languages - Context Sensitive Grammar (CSG), Linear Bounded Automata.Turing Machines - Standard Turing Machine, Robustness of Turing Machine, Universal Turing Machine, Halting Problem, Recursive and Recursively Enumerable Languages. Chomsky classification of formal languages.	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
CS1U30B	**Computer Networks**	**PCC**	**3**	**1**	**0**	**4**	**2022**

COURSE OVERVIEW

The 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 analyze 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:

Course Outcomes	Description	Level
CO 1	Explain the features of computer networks, protocols, and network design models	**Understand**
CO 2	Describe the fundamental characteristics of the physical layer and identify the usage in network communication	**Apply**
CO 3	Explain the design issues of data link layer, link layer protocols, bridges and switches	**Understand**
CO 4	Illustrate wired LAN protocols (IEEE 802.3) and wireless LAN protocols (IEEE 802.11)	**Understand**
CO 5	Select appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for a network	**Apply**
CO 6	Illustrate the functions and protocols of the network layer, transport layer, and application layer in inter-networking	**Understand**

SYLLABUS

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

REFERENCES

. 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	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.	**12**
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.	**12**
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**
	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
CS1U30K	**Operating Systems**	**PCC**	**3**	**1**	**0**	**4**	**2022**

PRE-REQUISITE: CS1U20A Data Structures and ES0U10G Problem Solving and Programming 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:

Course Outcomes	Description	Level
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

6. Andrew S Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice Hall, 2015.
7. William Stallings, “Operating systems”, 6th Edition, Pearson, Global Edition, 2015.
8. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, “Operating Systems”, 3rd Edition, Pearson Education,2016.
9. D.M. Dhamdhere, “Operating Systems”, 2nd Edition, Tata McGraw Hill, 2011.
10. 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
CS2U30C	**Introduction To Machine Learning**	**PCC**	**3**	**1**	**0**	**4**	**2022**

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.

Prerequisite: ES0U10H Introduction to Python

ii. COURSE OUTCOMES

Course Outcomes	Description	Level
CO1	Illustrate Machine Learning concepts and basics of supervised learning concepts.	Apply
CO2	Illustrate and evaluate supervised learning techniques	Apply
CO3	Solve real life problems using appropriate machine learning models	Apply
CO4	Illustrate basics of parameter estimation models and the working of SVM classifier	Apply
CO5	Demonstrate the use of dimensionality reduction techniques and unsupervised learning concepts	Apply

iii. SYLLABUS

iv (a) TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Reference Books

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. Mohammed J. Zaki and Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, First South Asia edition, 2016.

7. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016

8. 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	Hours
I	Introduction to Machine Learning, Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Classfication, regression and clustering , Basics of parameter estimation - Maximum Likelihood Estimation(MLE) and Maximum a Posteriori estimation(MAP). Bias-Variance decomposition Intel AI tools • Jupyter* Lab for interactive coding • NumPy, SciPy, and pandas for numerical computation • Matplotlib and seaborn for data visualization • Intel optimised library –modin Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method • Scikitlearn	**12**
II	KNN Classifier and Regressor Logistic Regression Model Evaluation-Bias-Variance-tradeoff, Overfitting and under fitting, Cost function Regularization –L1 and L2 DT in regression Bayes theorem, Naive Bayes Classifier Decision tree algorithm ID3, CART Case Study: Develop a classifier for face detection.	**12**
III	Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve AUC. Bootstrapping, Cross Validation. Support Vector Machines - Introduction, Maximum Margin hyperplanes, Mathematics behind Maximum Margin Classification, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF), Kernel Trick.	**12**
IV	Dimensionality reduction – Subset selection, Principal Component Analysis. Unsupervised Learning - Clustering Methods -Similarity measures, K-means clustering Expectation-Maximization for soft clustering, Hierarchical Clustering Methods – Agglomerative and divisive, Density based clustering.	**12**

	Ensemble methods, Voting, Bagging, Boosting.	
V	Association Rule Mining- Apriori algorithm Perceptron, Perceptron Learning, Multilayer Feed forward Network, Activation Functions (Sigmoid, ReLU,Tanh), Back Propagation Algorithm, Illustrative Example for Back Propagation	**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
CS2U30D	Artificial Neural Network	PCC	3	1	0	4	2022

COURSE OVERVIEW

This course provides a comprehensive introduction to Artificial Neural Networks, a fundamental concept in the field of machine learning and artificial intelligence. Students will gain a deep understanding of the theoretical foundations, practical applications, and design principles of neural networks.

COURSE OUTCOMES:

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

Course Outcomes	Description	Level
CO 1	Explain the fundamentals of artificial neural networks and their applications.	Understand
CO 2	Apply supervised learning techniques, including Perceptron learning and α-Least Mean Square Learning, to solve practical problems	Apply
CO 3	Implement the Backpropagation algorithm for designing and evaluating multi-layered network architectures.	Apply
CO 4	Explain the architecture and learning techniques of various Attractor Neural Networks	Understand
CO 5	Explain the principles of self-organizing feature maps and their practical applications.	Understand

SYLLABUS

TEXTBOOKS

1. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004.

REFERENCE BOOKS:

1. Simon Haykin, "Neural Networks: A comprehensive foundation", Second Edition, Pearson Education Asia.
2. Robert J. Schalkoff, "Artificial Neural Networks", McGraw-Hill International Editions, 1997
3. B. Yegnanarayana. "Artificial neural networks"., PHI Learning Pvt. Ltd.

COURSE PLAN

Module	Contents	No. of hours
I	**Introduction**: Biological Neuron-Artificial Neural Model - Types of activation functions - Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks.	12
II	**Supervised Learning I**: Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNS, Perceptron Learning Algorithm, Perceptron Convergence Theorem. Perceptron learning and Non-Separable sets, α-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, μ-LMS approximate to gradient descent, Application of LMS to Noise Cancellation.	12
III	**Supervised Learning II:** Multi-layered Network Architecture, Backpropagation Learning Algorithm, Practical consideration of BP algorithm, Applications of Feedforward Neural Networks.	12
IV	**Attractor Neural Networks**: Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box Neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	12
V	**Self-organization Feature Map**: Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self- organization Feature Maps, Application of SOM, Growing Neural Gas.	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

NC0U30A	**DISASTER MANAGEMENT**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		MNC	**2**	**0**	**0**	**Nil**	**2022**

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 andthe measures to reduce disaster risks.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts and terminology related to disaster management cycle	Understand
CO 2	Explain hazard and vulnerability types and disaster riskassessment	Understand
CO 3	Describe the process of risk assessment and appropriatemethodologies to assess risk	Understand
CO 4	Explain the core elements and phases of disaster risk management and measures to reduce disaster risks across sectorand 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

5. Coppola, D.P., *Introduction to International Disaster Management*, Elsevier

Science(B/H), London, 2020
6. Srivastava, H.N., Gupta, G.D., *Management of Natural Disasters in developing countries*,Daya Publishers, Delhi, 2007
7. Subramanian, R., *Disaster Management*, Vikas Publishing House, 2018
8. Sulphey, M.M., Disaster *Management*, PHI Learning, 2016

REFERENCE MATERIALS

6. NDMA, National Policy on Disaster Management, Ministry of Home Affairs,Government of India,2009.
7. National Disaster Management Division, Disaster Management in India - A Status Report, Ministry of Home Affairs, Government of India, New Delhi,2004.
8. National Disaster Management Plan, NDMA, Ministry of Home Affairs, Government ofIndia,2019.
9. Disaster Management Training Manual, UNDP, 2016
10. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster RiskReduction 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 preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment	6
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 ofdisaster risk management Phases of disaster risk management, Measures for disaster riskreduction Measures for disaster prevention, mitigation, and preparedness Disaster response- objectives, requirements. Disaster responseplanning; 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	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
CS2U38A	Operating Systems and Networking Lab	PCC	0	0	4	2	2022

PRE-REQUISITE: Nil

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:

Course Outcomes	Description	Level
CO 1	Implement Process Creation and Inter Process Communication in Operating Systems.	Apply
CO 2	Implement Process Synchronization algorithms in Operating Systems	Apply
CO 3	Implement modules for Deadlock Detection and Deadlock Avoidance in Operating Systems.	Apply
CO 4	Implement Medium Access Protocols	Apply
CO 5	Implement Transport Layer Protocols	Apply
CO 6	Implement Remote Procedure Calls	Apply

REFERENCES

4. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.
5. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2015.
6. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.

COURSE PLAN

SL No.	Topics	No. of hours
1	Implement programs for Inter Process Communication using PIPE, Message Queue and Shared Memory.	8

2	Write a program to simulate the working of the dining philosopher's problem.	8
3	Implement the banker's algorithm for deadlock avoidance.	8
4	Software simulation of Medium Access Control Protocols- 1) Go Back N 2) Selective Repeat and 3) Sliding Window	9
5	Implementation of a subset of simple mail transfer protocol using UDP	9
6	Implementation of a subset of a file transfer protocol using TCP/IP	9
7	Implementation of Remote Procedure Call (RPC)	9
	Total	**60**

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

Course Code	Course Name	Category	L	T	P	Credit	Year of Introduction
CS2U38B	Machine Learning Lab	PCC	0	0	4	2	2022

COURSE OVERVIEW:

This course enables the learners to get hands-on experience in most popular supervised learning algorithms (such as linear regression, logistic regression, decision trees, Bayesian learning and Naive Bayes algorithm) and unsupervised learning algorithms (such as basic clustering algorithms). This helps the learners to understand the process of knowledge inference from raw data through dataset preprocessing and analysis.

Prerequisite: Fundamentals of Programming, Python programming fundamentals, Machine learning.

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COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Implement machine learning algorithms using packages and libraries in Python for various applications	Apply
CO 2	Implement python programs for supervised learning methods through Neural network, Regression, and classification	Apply
CO 3	Implement clustering algorithms.	Apply
CO 4	Apply dimensionality reduction as a dataset preprocessing step.	Apply

TEXT BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

COURSE PLAN

SL No .	Topics	No. of hours
	Pandas ,Numpy and Visualization tools	20
11.	Implement K-Nearest Neighbor algorithm to classify any dataset	4
12.	Implement and demonstrate Single, Multi variable and Polynomial Regression for a given set of training data stored in a .CSV file and evaluate the accuracy.	4
13.	Implement a Python program to perform logistic regression on a dataset.	4
14.	Write a Python program to implement Naive Bayes classifier and calculate the accuracy, precision, and recall for your data set.	4
15.	Write a Python program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	4
16.	Assuming a set of data that need to be classified, use a Support Vector Machine classifier to perform this task and evaluate the accuracy.	4
17.	Implement dimensionality reduction using PCA.	4
18.	Implement K-Means Clustering using any given dataset.	4
19.	Implement Agglomerative Hierarchical Clustering.	4
20.	Build an Artificial Neural Network using Backpropagation algorithm and test the same with appropriate dataset.	4
	Total	60

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

Minor Basket 1: SOFTWARE ENGINEERING

Course Code	Course Name	Category	L	T	P		Credit		Year of Introduction
CS0M30A	**Concepts In Software Engineering**	**VAC**	**3**	**1**	**0**		**4**		**2022**

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.

Prerequisite: Basic understanding of Object Oriented Design and Development.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Differentiate Traditional and Agile Software Development approaches	Understand
CO 2	Prepare Software Requirement **Specification** and Software Design for a given problem.	Apply
CO 3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project	Apply
CO 4	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.	Apply
CO 5	Utilize SQA practices, Process Improvement techniques and Technology improvements namely cloud based software model and containers & microservices in a Software Development Process.	Apply

SYLLABUS

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.

Functional and non-functional requirements, Developing use cases, Software Requirements Specification Template, Personas, Scenarios, User stories, Feature identification. Design concepts Architectural Design - Software Architecture, Architectural Styles, Architectural considerations, Architectural Design Component level design Template of a Design Document as per "IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions".

Object-oriented design using the UML, Design patterns, Implementation issues, Open-source development - Open-source licensing - GPL, LGPL, BSD. DevOps automation, CI/CD/CD. Software Evolution - Evolution processes, Software maintenance.

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
Software Quality, Software Quality Dilemma, Achieving Software Quality Elements of Software Quality Assurance, SQA Tasks

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.

REFERENCES

7. Mary Poppendieck, Implementing Lean Software Development: From Concept to Cash, Addison-Wesley Signature Series, 2006
8. StarUML documentation - https://docs.staruml.io/
9. OpenProject documentation - https://docs.openproject.org/
10. BugZilla documentation - https://www.bugzilla.org/docs/
11. GitHub documentation - https://guides.github.com/
12. Jira documentation - https://www.atlassian.com/software/jira

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Software Engineering:** 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.	12
II	**Requirement Analysis and Design:** 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	12

	as per “IEEE Std 1016-2009 IEEE Standard for Information Technology Systems Design Software Design Descriptions”. Case study: The Ariane 5 launcher failure**.**	
III	**Implementation and Testing:** 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.	**12**
IV	**Software Project Management:** 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 and Process Improvement:** 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.	**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

Minor Basket 2: MACHINE LEARNING

Course Code	Course Name	Category	L	T	P		Credit		Year of Introduction
CS0M30B	**Concepts In Machine Learning**	**VAC**	**3**	**1**	**0**		**4**		**2022**

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.

Prerequisite: Familiarity with basics in linear algebra, probability and Python programming.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate Machine Learning concepts and basic parameter estimation methods.	Apply
CO 2	Demonstrate supervised learning concepts (regression, linear classification).	Apply
CO 3	Illustrate the concepts of Multilayer neural network and Support Vector Machine	Apply
CO 4	Describe unsupervised learning concepts and dimensionality reduction techniques.	Apply
CO 5	Solve real life problems using appropriate machine learning models and evaluate the performance measures	Apply

SYLLABUS

Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. - Linear regression, Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3.NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), 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.
Classification Performance measures

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.

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.

COURSE PLAN

Module	Contents	Hours
I	**Overview of machine learning:** 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.	**12**
II	**Supervised Learning** 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.	**12**
III	**Neural Networks (NN) and Support Vector Machines (SVM)** NN - Multilayer feed forward network, Activation functions (Sigmoid, ReLU, Tanh), Backpropagation algorithm. SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial Basis Function(RBF).	**12**
IV	**Unsupervised Learning:** Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation	**12**

	maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	
V	**Classification Assessment:** 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.	**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

Minor Basket 3: Networking

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.	Understand
CO 2	Outline the architecture and classifications of client/server systems.	Understand
CO 3	Summarize the client/server network services for an application.	Understand
CO 4	Identify management services and issues in network	Understand
CO 5	Outline the Client/Server technology in respect of databases and Client/Server database architecture	Understand

SYLLABUS

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

TEXT BOOKS

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

REFERENCE

5. Jeffrey D. Schank, “N0ovell’s Guide to Client-Server Application & Architecture” Novell Press
6. Robert Orfali, Dan Harkey, Jeri Edwards, Client/Server Survival Guide, Wiley-India Edition,

Third Edition

7. Dawna Travis Dewire, Client Server Computing- McGraw Hill
8. 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. Software Distribution, Performance, Network management. Remote Systems Management- RDP, Telnet, SSH, Security. LAN and Network Management issues.	**13**
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	**12**

	Programming Interface, Database Translator, Network Translator.	

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

Honour Basket 1: Security in Computing

CS1H30A	**CRYPTOGRAPHIC ALGORITHMS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		VAC	**3**	**1**	**0**	**4**	**2022**

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.	Understand
CO2	Summarize the classical encryption techniques for information hiding.	Apply
CO3	Illustrate symmetric / asymmetric key cryptographic algorithms for secure communication.	Apply
CO4	Interpret key management techniques for secure communication.	Understand
CO5	Summarize message authentication functions in a secure communication scenario.	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

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

REFERENCE MATERIALS

5. Behrouz A. Forouzan, Cryptography and Network Security, McGraw Hill, 2e.
6. Johannes A. Buchmann, Introduction to Cryptography, Springer, 2e.
7. DouglasR. Stinson, Cryptography Theory and Practice, 3e, Chapman& Hall/CRC, 2006.
8. 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

CS2H30A	Computational Biology	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2022

Honour Basket 2: COMPUTATIONAL BIOLOGY

COURSE OVERVIEW:

This course helps the learners to understand concepts in Genomics, Proteomics Computational Biology, Next Generation Sequencing, NGS Data Analysis and Systems biology. It enables the learners to understand various Next Generation Sequencing Techniques, analysis and interpretation of the NGS Data. Also, course introduces computational and mathematical analysis and modeling of complex biological systems and Systems Biology.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the basic concepts of genomics, microarray, protein structure determination and prediction	**Understand**
CO 2	Explain the fundamental aspects drug discovery and molecular modelling	**Apply**
CO 3	Demonstrate Networks in Biology, types of networks and its representation	**Apply**
CO 4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis	**Understand**
CO 5	Illustrate Next Generation sequence analysis, Mapping approaches and algorithms	**Understand**

SYLLABUS

Genomics and Proteomics, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure, Computer Aided Drug Discovery, Molecular modelling, Computer Aided Drug Discovery, Network Biology, (Next Generation Sequencing and analysis, NGS Data Analysis

TEXT BOOKS

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

REFERENCE MATERIALS

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

COURSE PLAN

Module	Contents	No. of hours
I	Genes, Genes in genomes, Genomes of prokaryotes and Eukaryotes, Protein-coding genes, RNA, Single-nucleotide polymorphisms, Microarray, Analysis of microarray data, Proteins and peptides, Experimental Protein structure identification, computational methods for protein structure prediction, Homology modelling, Protein folding and fold recognition	10
II	Drug discovery pipeline, Drug target identification & validation, Active site identification, pharmacophore, Lead/Ligand identification, lead compound optimization, Binding energy calculation, Energy Minimization. Molecular modelling in drug discovery, concept of Molecular Dynamics, concept of Absorption, Distribution, Metabolism and Excretion (ADME), Quantitative Structure-Activity Relationships	10
III	Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein-Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation	14
IV	A Typical NGS Experimental Workflow, Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq)	13
V	Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms, Selection of Mapping Algorithms and Reference Genome Sequences, SAM/BAM as the Standard Mapping File Format, Mapping File Examination and Operation, Tertiary Analysis	13

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

Honour Basket 3: COMPTER VISION

CS2H30B	Advanced Concepts in Computer Vision	Category	L	T	P	Credit	Year of Introduction
		VAC	3	1	0	4	2022

COURSE OVERVIEW:

This course enables the learners to understand the advanced concepts in computer vision. The course covers the basics of image processing, imaging geometry, image segmentation, feature extraction, object recognition and classification and common applications of computer vision. This course helps the students to design solutions for complex real-life problems.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Illustrate the concepts of image formation and image model.	**Understand**
CO 2	Demonstrate various feature extraction and edge detection techniques.	**Apply**
CO 3	Apply edge-based and region-based image segmentation techniques.	**Apply**
CO 4	Understand and implement image recognition and classification methods.	**Apply**
CO 5	Explain the various applications of computer vision	**Understand**

SYLLABUS

Image Formation and Processing, Fundamentals of Image processing, Feature Extraction, Edges Image Segmentation, Image processing using OpenCV - blending, smoothing, and reshaping. Image Recognition and Classification, Object classification using CNNs, Applications,

TEXT BOOKS

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.

3 Francesco Camastra, Alessandro Vinciarelli, "Machine Learning for Audio, Image and Video Analysis: Theory and Applications", Springer 2015.

REFERENCES

1. Reinhard Klette, "Concise Computer Vision: An Introduction into Theory and Algorithms", Springer London, 2014.
2. Olivier Faugeras, "Three-Dimensional Computer Vision", The MIT Press, 1993.

COURSE PLAN

Module	Contents	No. of hours
I	Image formation and Image model- Components of a vision system- Cameras- camera model and camera calibration-Radiometry- Light in space- Light in surface - Sources, shadows and shading. Fundamentals of Image processing: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels	**10**
II	Points and Patches – Feature detectors, feature descriptors, feature matching, feature tracking. Edges – edge detection, edge linking. Lines - Successive approximation, Hough transforms, Vanishing points.	**10**
III	Classification of segmentation techniques, Edge detection, Edge linking, Thresholding, Region growing, Region splitting and merging, Watershed based segmentation. Shadow detection and removal. Image processing using OpenCV - blending, smoothing, and reshaping.	**14**
IV	Shape based object classification, Motion based object classification, Viola Jones Object Detection Framework, Object classification using CNNs, use of RCNN for object classification	**13**
V	Speech and Handwriting Recognition, Automatic Face Recognition, Video Segmentation and Keyframe Extraction, Real-Time Hand Pose Recognition.	**13**

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

Course Code	Course Name	Category	L	T	P		Credit	Year of Introduction
CS2U30E	ROBOTICS AND INTELLIGENT SYSTEM	**PCC**	**3**	**1**	**0**		**4**	**2022**

COURSE OVERVIEW

This course enables the learners to understand the fundamental concepts and algorithms in Robotics and Intelligent systems. The course covers the standard hardware and kinematic concepts for robot design. Standard algorithms for localization, mapping, path planning, navigation and obstacle avoidance, to incorporate intelligence in robots are included in the course. This course helps the students to design robots with intelligence in a real world environment.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concepts of manipulator and mobile robotics.	**Understand**
CO 2	Choose the suitable sensors, actuators and control for robot design.	**Apply**
CO 3	Developing kinematic model of mobile robot and understand robotic vision intelligence.	**Apply**
CO 4	Make use of the localization and mapping methods in robotics	**Apply**
CO 5	Plan the path and navigation of robot by applying artificial intelligence algorithm	**Apply**

SYLLABUS

Introduction to robotics - Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots. Dynamic characteristics. Introduction to End effectors , Ethics in robotics - 3 laws - applications of robots. Sensor classification, Internal sensors-External sensors, Digital, Sensor characteristics. Actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control. Robotic Vision: Camera sensor hardware interfacing. Representation of Transformations, Pure Rotation about an Axis - Combined Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot. Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization Current challenges in map representation. Probabilistic map-based localization, Path Planning and Navigation

TEXT BOOKS

6. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots ,, MIT Press, USA, 2011
7. Thomas Bräunl - Embedded Robotics,Mobile Robot Design and Applications with Embedded Systems-Springer (2006)
8. S.G. Tzafestas - Introduction to Mobile Robot Control-Elsevier (2014)
9. Francis X. Govers - Artificial Intelligence for Robotics-Packt Publishing (2018)
10. Saeed B. Niku - Introduction to Robotics_ Analysis, Control, Applications

REFERENCES

4. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005
5. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
6. Peter Corke - Robotics, Vision and Control_ Fundamental Algorithms in MATLAB® - Springer-Verlag Berlin Heidelberg (2021)

COURSE PLAN

Module	Contents	Hours
I	Introduction to robotics – Degrees of freedom, Robot types- Manipulators- Anatomy of a robotic manipulator-links, joints, actuators, sensors, controllers. Robot configurations-PPP, RPP, RRP, RRR. Mobile robots- wheeled, legged, aerial robots, underwater robots, surface water robots . Dynamic characteristics- speed of motion, load carrying capacity & speed of response. Introduction to End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and Passive grippers. Ethics in robotics - 3 laws - applications of robots.	**12**
II	Sensor classification- touch, force, proximity, vision sensors. Internal sensors- Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Digital Camera - CCD camera - CMOS camera - Omnidirectional cameras Sensor characteristics. Actuators - DC Motors - H-Bridge - Pulse Width Modulation - Stepper Motors – Servos, Hydraulic & pneumatic actuators. Control - On-Off Control - PID Control - Velocity Control and Position Control	**12**
III	Robotic Vision: Sensing, Pre-processing, Segmentation, Description, Recognition, Interpretation, Feature extraction -Camera sensor hardware interfacing. Representation of Transformations - Representation of a Pure Translation - - Pure Rotation about an Axis - Combined Transformations - Transformations Relative to the Rotating Frame. Basic understanding of Differential-Drive Wheeled Mobile Robot, Car-Like Wheeled Mobile Robot. Kinematic model of a differential drive and a steered mobile robot, Degree of freedom and manoeuvrability, Degree of steerability, Degree of mobility - different wheel configurations, holonomic and nonholonomic robots. Omnidirectional Wheeled Mobile Robots	**12**
IV	Position and Orientation - Representing robot position. Basics of reactive navigation; Robot Localization, Challenges in localization - An error model for odometric position estimation Map Representation - Continuous representations - Decomposition strategies - Current challenges in map representation. Probabilistic map-based localization (only Kalman method), Autonomous map building, Simultaneous localization and mapping (SLAM) - Mathematical definition of SLAM - Visual SLAM with a single camera - Graph-based SLAM - Particle filter SLAM - Open challenges in SLAM	**12**

V	Path Planning- Graph search, deterministic graph search - , breadth first search - depth first search- Dijkstra’ s algorithm, A*, D* algorithms, Potential field based path planning. Obstacle avoidance - Bug algorithm - Vector Field Histogram - Dynamic window approaches. Navigation Architectures - Modularity for code reuse and sharing - Control localization - Techniques for decomposition. Alternatives for navigation - Neural networks - Processing the image - Training the neural network for navigation - Convolutional neural network robot control implementation	**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

CS1U30H	ALGORITHM ANALYSIS AND DESIGN	Category	L	T	P	Credit	Year of Introduction
		PCC	3	1	0	4	2022

PRE-REQUISITE: ES0U10E Programming in C, CS1U20A Data Structures , 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

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

SYLLABUS

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

TEXT BOOKS

5. T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein, Introduction to Algorithms, 2nd Edition, Prentice-Hall India (2001)
6. Ellis Horowitz, SartajSahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, Orient Longman Universities Press (2008)
7. Sara Baase and Allen Van Gelder ―Computer Algorithms, Introduction to Design and
8. 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
	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

CS1U30E	**MANAGEMENT OF SOFTWARE SYSTEMS**	**Category**	**L**	**T**	**P**	**Credit**	**Year of Introduction**
		PCC	**3**	**0**	**0**	**3**	**2022**

PRE-REQUISITE: CS2U20A Object Oriented Programming using Python.

COURSE OVERVIEW: This course provides fundamental knowledge in the Software Development Process. It c
Software Development, Quality Assurance, Project Management concepts and technology trends. This course enable
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

Course Outcomes	Description	Level
CO1	Demonstrate Traditional and Agile Software Development approaches	**Apply**
CO2	Prepare Software Requirement Specification and Software Design for a given problem.	**Apply**
CO3	Justify the significance of design patterns and licensing terms in software development, prepare testing, maintenance and DevOps strategies for a project.	**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.	**Apply**
CO5	Utilize SQA practices, Process Improvement techniques and Technology advancements in cloud based software models and containers & microservices.	**Apply**

SYLLABUS

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

TEXT BOOKS

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

REFERENCE MATERIALS

7. IEEE Std 830-1998 - IEEE Recommended Practice for Software Requirements Specifications
8. IEEE Std 1016-2009 IEEE Standard for Information Technology—Systems Design— Software Design Descriptions
9. David J. Anderson, Kanban, Blue Hole Press 2010
10. David J. Anderson, Agile Management for Software Engineering, Pearson, 2003
11. Walker Royce, Software Project Management : A unified framework, Pearson Education, 1998
12. Steve. Denning, The age of agile, how smart companies are transforming the way work gets done. New York, Amacom, 2018.

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 (CI/CD/CD). Software Evolution - Evolution processes, Software maintenance.	**11**
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**
	Total Hours	**45**

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.)

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	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

CS2U30I	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	1	0	0	1	2022

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. **Introduction to Machine Learning**

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

Course Outcomes	Description	Level
CO1	Comprehend the concepts and applications of data structures	**Understand**
CO2	Comprehend the concepts, functions and algorithms in Operating System	**Understand**
CO3	Comprehend the organization and architecture of computer systems	**Understand**
CO4	Comprehend the fundamental principles of database design and manipulation	**Understand**
CO5	Comprehend the concepts in Machine Learning	**Understand**

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.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2U38C	**Robotics lab**	**PCC**	**0**	**0**	**3**		**2**	**2022**

COURSE OVERVIEW

Robotics lab provides students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarizing intelligent systems.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Interface different peripherals to arduino board	**Apply**
CO 2	Assemble a mobile robot with different sensors and actuators	**Apply**
CO 3	Familiarise about localisation of mobile robots	**Apply**
CO 4	Impart intelligence to robot using standard algorithms	**Apply**
CO 5	Familiarise the robot navigation	**Apply**

SYLLABUS

ROS Essentials

• Installing and Configuring Your ROS Environment—ROS Kinetic/Melodic/Compatible versions

• Familiarisation with ROS (Master, nodes, topics, messages, services, parameters and actions)

• Familiarisation with ROS Tools – Gazebo , Moveit , Rviz

• Creating Workspace and Package in ROS

LIST OF EXPERIMENTS

Any 4 experiments from each group are mandatory

Part A:

Interfacing sensors and actuators

1.Familiarisation of Arduino IDE, Arduino microcontroller I/O interfacing(LED, LCD, Serial Monitor)

2. Interfacing IR and Ultrasonic sensor with Arduino

3. Interfacing DC motors with arduino - speed and direction control

4. Interfacing Servo Motors with Arduino - angle of rotation

5. Calibration of sensors-sonar, IR sensors and obtain the calibration curve

6. Mobile Robot assembly

7. Networking with Arduino: GSM and Bluetooth

Part B:

Intelligent systems

8. Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file(Python/C++)

9. Localization of a mobile robot using LIDAR (ROS)

10. Touch Sensors interfacing and feedback system

11. Line following Robot using IR sensor

12. Obstacle avoidance of a mobile robot while moving to a point.

13. Object detection using any one standard algorithm

14. Navigation simulation using turtlebot using ROS

REFERENCES

1. Siegwart, Roland, Introduction to Autonomous Mobile Robots, Cambridge, Mass. : MIT Press, 2nd ed.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer 2021
3. John. J. Craig, Introduction to Robotics (Mechanics and control), Pearson Education Asia 2002.
4. S K Saha, Introduction to Robotics by Mc Graw Hill Education, 2014.
5. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
6. Dahiya, Ravinder S., Valle, Maurizio, Robotic Tactile Sensing, Springer, 2013. https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation

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

CS2U39A	MINI PROJECT	Category	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2022

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

Course Outcomes	Description	Level
CO1	Identify technically and economically feasible problems	**Apply**
CO2	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes	**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**

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
150	75	75

CONTINOUS ASSESSMENT EVALUATION PATTERN

Attendance	10 marks
Project Guide	15 marks
Project Report	10 marks

Minors

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction	
CS0M30D	INTRODUCTION TO SOFTWARE TESTING	**VAC**	**3**	**1**	**0**		**4**	**2022**	

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 PEX tool.

Prerequisite: NIL

COURSE OUTCOMES

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

Course Outcomes	Description	
CO 1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.	Understand
CO 2	Explain mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	Understand
CO 3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program	Understand
CO 4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.	Understand
CO 5	Illustrate the use of PEX tool with symbolic execution.	Understand

SYLLABUS

Software testing, Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, 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., 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. Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Introduction to Grey Box testing

TEXT BOOKS

1. Paul Ammann and JeffOffutt ,Introduction to Software Testing.
2. KshirasagarNaik and PriyadarshiTripathy, Software Testing And Quality Assurance: Theory And Practice.

REFERENCES

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	
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.	**12**
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 and Muclipse.	**12**
III	**Unit Testing - White Box Approaches :** 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	**12**
IV	**Unit Testing - Black Box Approaches :** Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the inputdomain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base	**12**

	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.	
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. PEX application Case Study – PEX.	**12**
Total Hours		

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	J	Credit	Year of Introduction	
CS0M30E	CONCEPTS IN DEEP LEARNING	VAC	3	1	0		4	2022	

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.

Prerequisite: Sound knowledge in Basics of linear algebra and probability theory.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Demonstrate basic concepts in machine learning.	Understand
CO 2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	Understand
CO 3	Demonstrate the concept of the feed forward neural network and its training process.	Apply
CO 4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	Apply
CO 5	Use different neural network/deep learning models for practical applications.	Apply

SYLLABUS

Neural Networks. Introduction to optimization– Convolutional Neural Networks Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet. Recurrent neural networks 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.

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

REFERENCES

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, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

COURSE PLAN

Module	Contents	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. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	**12**
II	**Optimization and Neural Networks :** 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.	**12**
III	**Convolutional Neural Network :** 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.	**12**
IV	**Recurrent Neural Network :** 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.	**12**
V	**Application Areas :** 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.	**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	J	Credit	Year of Introduction
CS0M30F	**WIRELESS NETWORKS AND IoT APPLICATIONS**	**VAC**	**3**	**1**	**0**		**4**	**2022**

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.

Prerequisite: Sound knowledge in Data Communication, Computer Networks and Programming in C.

COURSE OUTCOMES

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

Course Outcomes	Description
CO 1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO 2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO 3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO 4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO 5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO 6	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**

SYLLABUS

Module- 1 (Introduction to IoT and wireless technologies required for IoT)

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.

Module- 2 (IoT architecture, Data and Device management)

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 Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Module- 3 (Data Acquiring and Enabling Technologies)

Data Acquiring and Storage for IoT Sevices- 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

Module-4 (Prototyping the Embedded Devices for IoT)

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

Module 5 (Business Models and Case Studies)

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

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.

REFERENCES

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. 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

COURSE PLAN

Module	Contents	Hours
I	**Introduction to IoT and wireless technologies required for IoT :** Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT.	**12**

	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.	
II	**IoT architecture, Data and Device management :** 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 Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	**12**
III	**Data Acquiring and Enabling Technologies :** Data Acquiring and Storage for IoT Sevices- 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	**12**
IV	**Prototyping the Embedded Devices for IoT :** 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	**12**
V	**Business Models and Case Studies :** 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	**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

Honour Basket 1: SECURITY IN COMPUTING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS1H30D	NETWORK SECURITY	**VAC**	**3**	**1**	**0**		**4**	**2022**

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.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms

COURSE OUTCOMES

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

Course Outcomes	Description
CO 1	Identify the key aspects of security, intrusion detection systems and digital signature schemes (Cognitive Knowledge Level: Apply)
CO 2	Explain the security standards used in network communication (Cognitive Knowledge Level:Understand)
CO 3	Identify the mechanisms in email security services (Cognitive Knowledge Level: Apply)
CO 4	Summarize the protocols used to provide web security (Cognitive Knowledge Level: Understand)
CO 5	Explain the fundamental concepts of wireless network security and firewalls (Cognitive Knowledge Level: Understand)

SYLLABUS

Module – 1 (Network Security Basics) 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).

Module – 2 (Network Security Standards) 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-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security) 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.

Module – 4 (Web Security) 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.

Module – 5 (Wireless Network Security and Firewalls) 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.

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

REFERENCES

1. Behrouz A. Forouzan, Debdeep Mukhopadhyay, "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.
3. Schiller J., Mobile Communications, 2/e, Pearson Education.
4. Roberta Bragg et. al., "Network Security: The Complete Reference", Tata McGraw Hill.

COURSE PLAN

Module	Contents	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).	12
II	Module – 2 (Network Security Standards) 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-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.	12
III	Module – 3 (Email Security) 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.	12

IV	Module – 4 (Web Security) 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.	**12**
V	Module – 5 (Wireless Network Security and Firewalls) 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.	**12**
	Total Hours	**60**

Honour Basket 2: COMPUTATIONAL BIOLOGY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2H30C	MACHINE LEARNING IN COMPUTATIONAL BIOLOGY	**VAC**	**3**	**1**	**0**		**4**	**2022**

COURSE OVERVIEW

This course is intended to provide the learners a outlook towards application of Machine learning algorithms in the field of computational biology. This course helps the learners to apply the Machine learning methods - clustering algorithms, dimensionality reduction, decision drees, Artificial Neural Network, Support Vector Machine to the computational biology problems. Also the course discuss Challenges of Machine Learning in Computational Biology and Future directions of Machine Learning in Computational Biology

Prerequisite: Basic background in Bioinformatics and Machine Leaning

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the basic concepts of Machine Leaning, Classification, regression and clustering problems, parameters and measures	Under stand
CO 2	Demonstrate the clustering algorithm on computational biology problems	Apply
CO 3	Explain Dimensionality reduction techniques and Decision Trees in computational biology	Apply
CO 4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis	Apply
CO 5	Explain the role and challenges of Machine Learning in Computational	Under stand

SYLLABUS

TEXT BOOKS

1. Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications. Germany, Springer Singapore, 2020.
2. Yang, ZhengRong. Machine Learning Approaches to Bioinformatics. Singapore, World Scientific Publishing Company, 2010.

REFERENCES

1. Izadkhah, Habib. Deep Learning in Bioinformatics: Techniques and Applications in Practice. Netherlands, Elsevier Science, 2022.
2. Agapito, Giuseppe, et al. Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining. Netherlands, Elsevier Science, 2022.
3. Data Analytics in Bioinformatics: A Machine Learning Perspective. United States, Wiley, 2021.
4. Michailidis, George, et al. Introduction to Machine Learning and Bioinformatics. United Kingdom, CRC Press, 2008.
5. Zhang, Yanqing, and Rajapakse, Jagath C, Machine Learning in Bioinformatics, Germany, Wiley, 2009.
6. Baldi, Professor Pierre, et al. Bioinformatics, Second Edition: The Machine Learning Approach. India, Bradford, 2001.

COURSE PLAN

Module	Contents	Hours
I	Overview of Machine Learning- Overview of Machine Learning, fitting predictive models to data, Supervised and unsupervised learning, Classification, regression and clustering problems, Loss or cost functions. Parameters and hyperparameters, Training. validation and testing, Inductive bias and the bias variance trade-off, Use of clustering models.	**12**
II	Clustering problems Computational Biology Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of kMeans clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.	**12**
III	Supervised techniques for Computational Biology- Proteomics Dataset, Data Pre-processing Algorithms, Dimension and Feature Subset Selection, Dimensionality reduction - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Decision Trees in Bioinformatics, Proteomic Mass Spectra Classification Using Decision Tree Technique.	**12**
IV	Machine-Learning Algorithms for Computational Biology- Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics, Designing ANN for Bioinformatics, ANN in Protein Bioinformatics, Support Vector Machine with Feature Elimination.	**12**
V	Scope of Machine Learning in Computational Biology-Role of Machine Learning in Computational Biology, Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods, Future directions of Machine Learning in Computational Biology.	**12**
	Total Hours	**60**

Honour Basket 3: COMPUTER VISION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2H30D	IMAGE AND VIDEO PROCESSING	VAC	3	1	0		4	2022

COURSE OVERVIEW

This course enables the learners to understand how digital images are stored and processed. The learners are exposed to different spatial and frequency domain methods for image enhancement, image restoration techniques, morphological operations that could be performed on digital images and also various image and video compression techniques. The course also gives an introduction to the basics of video processing and video segmentation.

Prerequisite: Advanced Computer Graphics, Advanced Concepts in Computer Vision

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Summarize the steps of digital image processing and pixel relationships.	Understan d
CO 2	Apply spatial and frequency domain methods for image enhancement.	Apply
CO 3	Apply restoration techniques and morphological operations on digital images.	Apply
CO 4	Compare different methods for digital image and video compression.	Apply
CO 5	Understand the basics of video and video segmentation	Understan d

SYLLABUS pocessing

Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering,), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering, , Periodic Noise reduction by frequency domain filtering. Morphological Operations: Erosion, Dilation, Video processing

TEXT BOOKS

1. Gonzalez and Woods , "Digital Image Processing", 3rd edition , Pearson, 2009.
2. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu. "Fundamentals of multimedia", Pearson Prentice Hall, 2004.
3. Bovik, Alan C. "Handbook of image and video processing", Academic press, 2010.

REFERENCES

1. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.

2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
3. Maheshkumar H Kolekar, “Intelligent Video Surveillance Systems: An Algorithmic Approach”, CRC Press.
4. Francesco Camastra, Alessandro Vinciarelli, “Machine Learning for Audio, Image and Video Analysis: Theory and Applications”, Springer 2015.
5. M. Tekalp ,”Digital video Processing”, Prentice Hall International
6. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,
7. Yao wang, Joem Ostarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI

COURSE PLAN

Module	Contents	Hours
I	Module – 1 Fundamentals of Image processing: Basic steps of Image processing system, sampling and quantization of an Image, basic relationship between pixels and connectivity. Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.	**12**
II	Module -2 Image Transforms: Unitary transforms, 2D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering	**12**
III	Module - 3 Image Restoration: Image degradation/Restoration model, Noise models, Restoration in presence of noise only - spatial filtering, Periodic Noise reduction by frequency domain filtering. Morphological Operations: Erosion, Dilation, Opening, Closing, Hit-or-miss transformation, Boundary extraction.	**2**
IV	Module - 4 Image compression fundamentals – Coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, JPEG standards.	**12**
V	Module - 5 Video processing: Basics of Video Processing: Analog video, Digital Video. Video segmentation: Introduction to video segmentation, Change detection. COMPUTER SCIENCE AND ENGINEERING(ARTIFICIAL INTELLIGENCE) Video Compression: Introduction to video compression, video compression based on motion compensation, Search for motion vectors, H.261 standard, Transform coding, predictive codingMPEG.	**12**
	Total Hours	**60**

PROGRAM ELECTIVE I

Course Code	Course Name	Cate gory	L	T	P	J	Credit	Year of Introduction
CS1U31C	FOUNDATIONS OF SECURITY IN COMPUTING	PEC	2	1	0		3	2022

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.	**Understand**
CO2	Use the concepts of prime numbers and factorization for ensuring security in computing	**Apply**
CO3	Illustrate the concepts of Linear Congruence, Primitive Roots, Discrete Logarithms and Elliptic Curve Arithmetic	**Apply**
CO4	Summarize the threats and attacks related to computer and program security	**Understand**
CO5	Outline the key aspects of operating system and database security	**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 requirements of databases, Reliability and integrity, Database disclosure.	8
	Total Hours	45

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	J	Credit	Year of Introduction
CS1U31G	Applied Data Science with Python Industry elective	**PEC**	**2**	**0**	**2**		**3**	**2022**

PRE-REQUISITES

Python Basics: Basic Python syntax, Control structures (loops, conditionals), Functions and lambda functions, Basic data structures (lists, dictionaries, tuples, sets Mathematics: Linear Algebra, Calculus, Probability and Statistics, General Computing Knowledge: Familiarity with the command line or terminal, Basic understanding of how databases work, including SQL, Experience with a code editor or an Integrated Development Environment(IDE) like PyCharm or Visual Studio Code.

COURSE OVERVIEW

Applied Data Science with Python course, a comprehensive journey designed to equip you with th knowledge, skills, and tools necessary to thrive in today's data-driven world. This course serves as bridge between theoretical foundations and real-world applications, offering you the hands-c experience required to tackle actual data challenges.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Make use of Pandas library to effectively process complex datasets.	**Apply**
CO 2	Create effective data visualization using Python libraries	**Apply**
CO 3	Build machine learning and deep learning models using Python libraries	**Apply**
CO 4	Apply Natural Language Processing techniques in data analysis.	**Apply**
CO 5	Develop models using Time series data to solve real world problems	**Apply**

SYLLABUS

Introduction to Data Science and Python ,Data Manipulation with Pandas, Advanced Pandas-Merging, Joining and Concatenating, Pivot Tables, Time Series Analysis in Pandas, Data Visualization with Matplotlib and Seaborn, Seaborn for Statistical Visualization, Advanced Visualization Techniques, Exploratory Data Analysis (EDA),Visual EDA , Introduction to Machine Learning with Scikit-learn, Regression Techniques ,Classification Techniques, Model Evaluation ,Advanced Machine Learning Techniques, Ensemble Methods ,Unsupervised Learning ,Hyperparameter Tuning, Introduction to Deep Learning with TensorFlow/Keras. Understanding Neural Networks, Implementing Neural Networks, Introduction to Convolutional Neural Networks, Natural Language Processing with NLTK and SpaCy, Text Classification and Sentiment Analysis, Named Entity Recognition, Time Series Forecasting with Python, Forecasting Models, Data Science Project.

TEXT BOOKS

1. McKinney, W., 2022. Python for data analysis. " O'Reilly Media, Inc.".
2. Goodfellow, I., Bengio, Y. and Courville, A., 2016. Deep learning. MIT press.
3. Géron, A., 2022. Hands-on machine learning with Scikit-Learn, Keras and TensorFlow. " O'Reilly Media, Inc.".
4. Hapke, H., Howard, C. and Lane, H., 2019. Natural Language Processing in Action: Understanding, analyzing, and generating text with Python. Simon and Schuster.

REFERENCES

1. VanderPla, 2016. Jake. Python Data Science Handbook.
2. Andrew Park, 2021, Data Science for Beginners
3. Müller, A.C. and Guido, S., 2016. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.".
4. Muller, A.C. and Guido, S., 2017. Introduction to machine learning with Python. O'Reilly.

COURSE PLAN

Module	Contents	Hours
I	Introduction to Data Science and Python, What is Data Science, Introduction to Python, Why Python for Data Science?, Data Manipulation with Pandas, Introduction to Pandas ,Data Frames and Series, Basic Operations, Advanced Pandas	8
II	Data Visualization with Matplotlib and Seaborn, Matplotlib Basics ,Seaborn for Statistical Visualization ,Advanced Visualization Techniques Exploratory Data Analysis (EDA) Understanding EDA , Visual EDA -Univariate, Bivariate, and Multivariate Analysis- Correlation and Heatmaps	8
III	Regression Techniques: Fundamentals and advanced methods in regression analysis, Linear Regression, including its assumptions and performance evaluation using metrics like R^2 and RMSE. Multiple Linear Regression, emphasizing handling multicollinearity, interaction terms, and practical feature selection strategies like stepwise regression. Logistic Regression for binary classification problems with metrics such as accuracy, precision, and recall, along with a hands-on case study. Naive Bayes for Regression and Regularization Techniques such as Ridge, Lasso, and Elastic Net for addressing overfitting and multicollinearity. Polynomial Regression for modelling non-linear relationships(Optional)	10
IV	Machine Learning: Decision Trees and Random Forests, covering concepts like splitting criteria, feature importance, and ensemble methods. Advanced boosting techniques, including XGBoost and LightGBM, along with practical hyperparameter tuning using GridSearchCV and RandomizedSearchCV. Support Vector Machines (SVM) for regression (SVR), including kernel tricks	11

	for linear and non-linear patterns. Unsupervised learning with k-means Clustering for pattern recognition and segmentation, and Dimensionality Reduction using Principal Component Analysis (PCA) for visualizing high-dimensional data and preprocessing tasks.	
V	Time Series Forecasting with Python, Basics of Time Series Analysis Forecasting Models - ARIMA, Exponential Smoothing, Prophet Practical Data Science Project-Complete End-to-End Project Walkthrough Basics of NLP and Deep Learning (only one hour)	8
	Total Hours	**45**

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	J	Credit	Year of Introduction
CS2U31B	CONCEPTS IN COMPUTER GRAPHICS AND IMAGE PROCESSING	PEC	2	1	0		3	2022

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

Course Outcomes	Description	Level
CO1	Describe the working principles of graphics devices	**Understand**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	**Apply**
CO3	Demonstrate geometric representations, transformations on 2D & 3D objects, clipping algorithms and projection algorithms	**Apply**
CO4	Summarize visible surface detection methods	**Understand**
CO5	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships	**Apply**
CO6	Solve image enhancement and segmentation problems using spatial domain techniques	**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.	9
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.	9
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.	9
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.	9
V	Basic gray level transformation functions - Log transformations, Power-Law transformations, Contrast stretching. Histogram equalization. Basics of spatial filtering - Smoothing spatial filter-	9

	Linear and nonlinear filters, and Sharpening spatial filters-Gradient and Laplacian. 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	
	Total Hours	**45**

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	J	Credit	Year of Introduction
CS2U31C	**Object Oriented Programming using Java**	PEC	2	1	0	0	3	2022

PRE-REQUISITE: Nil

COURSE OVERVIEW

Aim of the course is to introduce Object oriented concepts in programming. The course introduces Object Oriented Principles, Object Oriented Programming in Java, Exception handling, Event handling, multithreaded programming and graphical user interface programming. The course will enable learners to solve problems by breaking it down to object level while designing software and implementing it using Java.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Summarize the Basic features and architecture of Java	Understand
CO 2	Construct Object Oriented Design using Unified Modelling Language (UML)	Apply
CO 3	Apply the object-oriented concepts - classes, objects, constructors, data hiding, inheritance, and polymorphism to write Java programs.	Apply
CO 4	Utilize packages & interfaces, input/output streams, files and string-handling mechanisms to develop programs	Apply
CO 5	Utilize exception handling, multithreading and database connectivity to develop java applications.	Apply
CO 6	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, String Handling, Comparison of String Buffer and String, Input/ Output - Reading Console Input, Writing Console Output, Object Streams and Serialization, Working with Files.

Exception Handling, 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).

TEXTBOOKS

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	Hours
I	Approaches to Software Design - Functional Oriented Design, Object Oriented Design, 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 Buzzwords, Java program structure, Comments, Garbage Collection.	**8**
II	Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. 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, 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.	**12**
III	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. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Input/ Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.	**8**
IV	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw,	**9**

	throws and finally. 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, and 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.	
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.	**8**
	Total Hours	**45**

M**ARK 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	J	Credit	Year of Introduction
CS2U31F	**Machine Learning Models and Storage Management**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2022**

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. This course aims to provide the basics for developing deployable machine learning systems. The course helps the students to provide machine learning based solutions to real world problems.

Prerequisite : Nil

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the basic concepts and techniques of Machine Learning.	**Understand**
CO 2	Demonstrate supervised learning techniques of classification and regression	**Apply**
CO 3	Illustrate the concepts of kernel functions, support vector machines and Markov model.	**Apply**
CO 4	Apply the techniques of clustering and multilayer neural networks.	**Apply**
CO 5	Summarize the process of development of a machine learning model in real-world applications.	**Understand**

SYLLABUS

Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance. Support Vector Machine, Hidden Markov models, Evaluation problem, finding state sequence, Learning model parameters. Clustering Methods Requirements for ML Systems - Iterative process for developing ML systems in production – Data Systems Fundamentals: data sources, data formats , data models, data storage engines and processing – Training data: Sampling techniques, Labelling, Handling class imbalance - Model Development and Training: Evaluating ML Models, Ensembles - Model Offline Evaluation: Baselines, Evaluation Methods – Model Deployment: Batch Prediction vs. Online Prediction, Model Compression, Model Optimization

TEXT BOOKS

1. Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine

Learning), MIT Press, 2004.
2. Huyen, Chip. Designing machine learning systems. " O'Reilly Media, Inc.", 2022.

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.

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Machine Learning:** Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis (VC) Dimension. Probably Approximately Learning (PAC), Noise, Learning Multiple classes, Model Selection and Generalization, Dimensionality reduction- Subset selection, Principal Component Analysis.	9
II	**Classification:** Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance- Precision, recall, ROC curves. Bayes Theorem, Bayesian classifier, Maximum Likelihood estimation, Density functions, Regression. Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Classification by Regression (CART).	9
III	**Kernel Machines:** Support Vector Machine- Optimal Separating hyper plane, Soft-margin hyperplane, Kernel trick, Kernel functions. Discrete Markov Processes, Hidden Markov models, Three basic problems of HMMs- Evaluation problem, finding state sequence, Learning model parameters. Combining multiple learners, Ways to achieve diversity, Model combination schemes, Voting, Bagging, Booting.	6
IV	**Unsupervised Learning:** Clustering Methods - K-means, Expectation-Maximization Algorithm, Hierarchical Clustering Methods, Density based clustering. Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation- Multi-Layer Perceptron in Practice – Examples of using the MLP- Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions.	6
V	**Designing ML Systems in Production:** Requirements for ML Systems - Iterative process for developing ML systems in production – Data Systems Fundamentals: data sources, data formats , data models, data storage engines and processing – Training data: Sampling techniques, Labelling, Handling class imbalance - Model Development and Training: Evaluating ML Models, Ensembles - Model Offline Evaluation: Baselines, Evaluation Methods – Model Deployment: Batch Prediction vs. Online Prediction, Model Compression,	15

	Model Optimization.	
	Total Hours	**45**

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

CS2U30I	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		PCC	1	0	0	1	2022

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. **Introduction to Machine Learning**

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

Course Outcomes	Description	Level
CO1	Comprehend the concepts and applications of data structures	**Understand**
CO2	Comprehend the concepts, functions and algorithms in Operating System	**Understand**
CO3	Comprehend the organization and architecture of computer systems	**Understand**
CO4	Comprehend the fundamental principles of database design and manipulation	**Understand**
CO5	Comprehend the concepts in Machine Learning	**Understand**

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.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2U38C	**Robotics lab**	**PCC**	**0**	**0**	**3**		**2**	**2022**

COURSE OVERVIEW

Robotics lab provides students with exposure to the common sensor and actuator interfacing, setting up mobile robots and familiarizing intelligent systems.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Interface different peripherals to arduino board	**Apply**
CO 2	Assemble a mobile robot with different sensors and actuators	**Apply**
CO 3	Familiarise about localisation of mobile robots	**Apply**
CO 4	Impart intelligence to robot using standard algorithms	**Apply**
CO 5	Familiarise the robot navigation	**Apply**

SYLLABUS

ROS Essentials

• Installing and Configuring Your ROS Environment—ROS Kinetic/Melodic/Compatible versions

• Familiarisation with ROS (Master, nodes, topics, messages, services, parameters and actions)

• Familiarisation with ROS Tools – Gazebo , Moveit , Rviz

• Creating Workspace and Package in ROS

LIST OF EXPERIMENTS

Any 4 experiments from each group are mandatory

Part A:

Interfacing sensors and actuators

1.Familiarisation of Arduino IDE, Arduino microcontroller I/O interfacing(LED, LCD, Serial Monitor)

2. Interfacing IR and Ultrasonic sensor with Arduino

3. Interfacing DC motors with arduino - speed and direction control

4. Interfacing Servo Motors with Arduino - angle of rotation

5. Calibration of sensors-sonar, IR sensors and obtain the calibration curve

6. Mobile Robot assembly

7. Networking with Arduino: GSM and Bluetooth

Part B:

Intelligent systems

8. Writing a Simple Publisher and Subscriber, Simple Service and Client, Recording and playing back data, Reading messages from a bag file(Python/C++)

9. Localization of a mobile robot using LIDAR (ROS)

10. Touch Sensors interfacing and feedback system

11. Line following Robot using IR sensor

12. Obstacle avoidance of a mobile robot while moving to a point.

13. Object detection using any one standard algorithm

14. Navigation simulation using turtlebot using ROS

REFERENCES

7. Siegwart, Roland, Introduction to Autonomous Mobile Robots, Cambridge, Mass. : MIT Press, 2nd ed.
8. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer 2021
9. John. J. Craig, Introduction to Robotics (Mechanics and control), Pearson Education Asia 2002.
10. S K Saha, Introduction to Robotics by Mc Graw Hill Education, 2014.
11. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
12. Dahiya, Ravinder S., Valle, Maurizio, Robotic Tactile Sensing, Springer, 2013. https://emanual.robotis.com/docs/en/platform/turtlebot3/simulation

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

CS2U39A	MINI PROJECT	Category	L	T	P	Credit	Year of Introduction
		PCC	0	0	3	2	2022

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

Course Outcomes	Description	Level
CO1	Identify technically and economically feasible problems	**Apply**
CO2	Identify and survey the relevant literature for getting exposed to related solutions and get familiarized with software development processes	**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**

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
150	75	75

CONTINOUS ASSESSMENT EVALUATION PATTERN

Attendance	10 marks
Project Guide	15 marks
Project Report	10 marks

Minors

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction	
CS0M30D	INTRODUCTION TO SOFTWARE TESTING	VAC	3	1	0		4	2022	

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 PEX tool.

Prerequisite: NIL

COURSE OUTCOMES

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

Course Outcomes	Description	
CO 1	List a range of different software testing techniques and be able to apply specific unit testing method to the projects using Junit.	Understand
CO 2	Explain mutation testing method for a given piece of code to identify hidden defects that can't be detected using other testing methods.	Understand
CO 3	Explain graph coverage criteria in terms of control flow graph and data flow graph for a given program	Understand
CO 4	Demonstrate the importance of black-box approaches in terms of domain and functional testing.	Understand
CO 5	Illustrate the use of PEX tool with symbolic execution.	Understand

SYLLABUS

Software testing, Types of Testing- Unit testing, integration testing, System testing, Acceptance testing, Beta testing, Concept of Unit testing. Static Unit testing. Dynamic Unit testing - Control Flow testing, Data Flow testing, Domain testing, 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., 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. Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Introduction to Grey Box testing

TEXT BOOKS

1. Paul Ammann and JeffOffutt ,Introduction to Software Testing.
2. KshirasagarNaik and PriyadarshiTripathy, Software Testing And Quality Assurance: Theory And Practice.

REFERENCES

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	
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.	**12**
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 and Muclipse.	**12**
III	**Unit Testing - White Box Approaches :** 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	**12**
IV	**Unit Testing - Black Box Approaches :** Domain Testing / Input Space Partitioning - Partitions of a set. Input domain modelling - Interface-based approach, Functionality-based approach. Identifying values. Multiple partitions of the inputdomain - All Combinations Coverage (ACoC), Each Choice Coverage (ECC), Pair-wise Coverage, T-wise Coverage, Base	**12**

	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.	
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. PEX application Case Study – PEX.	**12**
Total Hours		

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	J	Credit	Year of Introduction	
CS0M30E	CONCEPTS IN DEEP LEARNING	VAC	3	1	0		4	2022	

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.

Prerequisite: Sound knowledge in Basics of linear algebra and probability theory.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Demonstrate basic concepts in machine learning.	Understand
CO 2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets.	Understand
CO 3	Demonstrate the concept of the feed forward neural network and its training process.	Apply
CO 4	Build CNN and Recurrent Neural Network (RNN) models for different use cases.	Apply
CO 5	Use different neural network/deep learning models for practical applications.	Apply

SYLLABUS

Neural Networks. Introduction to optimization– Convolutional Neural Networks Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet. Recurrent neural networks 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.

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

REFERENCES

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, PradeepPujari,Packt Publishing 2018
3. Hands-On Deep Learning Algorithms with Python by SudharsanRavichandran,Packt Publishing 2019
4. Deep Learning with Python by Francois Chollet,Manning Publications Co.,2018

COURSE PLAN

Module	Contents	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. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	**12**
II	**Optimization and Neural Networks :** 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.	**12**
III	**Convolutional Neural Network :** 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.	**12**
IV	**Recurrent Neural Network :** 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.	**12**
V	**Application Areas :** 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.	**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	J	Credit	Year of Introduction
CS0M30F	**WIRELESS NETWORKS AND IoT APPLICATIONS**	**VAC**	**3**	**1**	**0**		**4**	**2022**

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.

Prerequisite: Sound knowledge in Data Communication, Computer Networks and Programming in C.

COURSE OUTCOMES

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

Course Outcomes	Description
CO 1	Recognize wireless technologies required for IoT ecosystem **(Cognitive Knowledge Level : Understand)**
CO 2	Perceive the concept of IoT and M2M architecture, IoT examples, and Data Management in IoT **(Cognitive Knowledge Level :Apply)**
CO 3	Outline the hardware components used in IoT including Sensors, Actuators and development boards **(Cognitive Knowledge Level : understand)**
CO 4	Explain the software components of IoT **(Cognitive Knowledge Level :Understand)**
CO 5	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**
CO 6	Demonstrate the protocols used in IoT and build IoT Programs **(Cognitive Knowledge Level : Apply)**

SYLLABUS

Module- 1 (Introduction to IoT and wireless technologies required for IoT)
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.

Module- 2 (IoT architecture, Data and Device management)
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 Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.

Module- 3 (Data Acquiring and Enabling Technologies)

Data Acquiring and Storage for IoT Sevices- 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

Module-4 (Prototyping the Embedded Devices for IoT)

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

Module 5 (Business Models and Case Studies)

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

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.

REFERENCES

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. 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

COURSE PLAN

Module	Contents	Hours
I	**Introduction to IoT and wireless technologies required for IoT :** Internet of Things, Role of Things and the Internet, Wireless IoT. Wireless Networks - Network Topologies, Types of Networks. Role of Wireless Standards in IoT.	12

	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.	
II	**IoT architecture, Data and Device management :** 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 Devices, Web Connectivity for Connected Devices using Gateways. Internet Connectivity Principles – Internet Connectivity, Internet based communication, IP addressing in the IoT.	**12**
III	**Data Acquiring and Enabling Technologies :** Data Acquiring and Storage for IoT Sevices- 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	**12**
IV	**Prototyping the Embedded Devices for IoT :** 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	**12**
V	**Business Models and Case Studies :** 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	**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

Honour Basket 1: SECURITY IN COMPUTING

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS1H30D	NETWORK SECURITY	**VAC**	**3**	**1**	**0**		**4**	**2022**

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.

Prerequisite: A sound background in Number Theory and Cryptographic Algorithms

COURSE OUTCOMES

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

Course Outcomes	Description
CO 1	Identify the key aspects of security, intrusion detection systems and digital signature schemes (Cognitive Knowledge Level: Apply)
CO 2	Explain the security standards used in network communication (Cognitive Knowledge Level:Understand)
CO 3	Identify the mechanisms in email security services (Cognitive Knowledge Level: Apply)
CO 4	Summarize the protocols used to provide web security (Cognitive Knowledge Level: Understand)
CO 5	Explain the fundamental concepts of wireless network security and firewalls (Cognitive Knowledge Level: Understand)

SYLLABUS

Module – 1 (Network Security Basics) 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).

Module – 2 (Network Security Standards) 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-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.

Module – 3 (Email Security) 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.

Module – 4 (Web Security) 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.

Module – 5 (Wireless Network Security and Firewalls) 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.

TEXT BOOKS

3. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a Public World”, 2/e, PHI.
4. William Stallings, “Cryptography and Network Security Principles and Practice”, 5/e, Pearson

REFERENCES

5. Behrouz A. Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 3/e, Tata McGraw Hill.
6. 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.
7. Schiller J., Mobile Communications, 2/e, Pearson Education.
8. Roberta Bragg et. al., “Network Security: The Complete Reference”, Tata McGraw Hill.

COURSE PLAN

Module	Contents	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).	12
II	Module – 2 (Network Security Standards) 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-ofService protection, Endpoint identifier hiding, Live partner reassurance. Internet Protocol Security (IPSec) - Authentication Header (AH), Encapsulating Security Payload (ESP), Internet Key Exchange (IKE) phases.	12
III	Module – 3 (Email Security) 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.	12

IV	Module – 4 (Web Security) 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.	**12**
V	Module – 5 (Wireless Network Security and Firewalls) 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.	**12**
	Total Hours	**60**

Honour Basket 2: COMPUTATIONAL BIOLOGY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2H30C	MACHINE LEARNING IN COMPUTATIONAL BIOLOGY	**VAC**	**3**	**1**	**0**		**4**	**2022**

COURSE OVERVIEW

This course is intended to provide the learners a outlook towards application of Machine learning algorithms in the field of computational biology. This course helps the learners to apply the Machine learning methods - clustering algorithms, dimensionality reduction, decision drees, Artificial Neural Network, Support Vector Machine to the computational biology problems. Also the course discuss Challenges of Machine Learning in Computational Biology and Future directions of Machine Learning in Computational Biology

Prerequisite: Basic background in Bioinformatics and Machine Leaning

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the basic concepts of Machine Leaning, Classification, regression and clustering problems, parameters and measures	Under stand
CO 2	Demonstrate the clustering algorithm on computational biology problems	Apply
CO 3	Explain Dimensionality reduction techniques and Decision Trees in computational biology	Apply
CO 4	Illustrate Feature Extraction and Pattern recognition and Classification in the domain of Computational Biology analysis	Apply
CO 5	Explain the role and challenges of Machine Learning in Computational	Under stand

SYLLABUS

TEXT BOOKS

3. Statistical Modelling and Machine Learning Principles for Bioinformatics Techniques, Tools, and Applications. Germany, Springer Singapore, 2020.
4. Yang, ZhengRong. Machine Learning Approaches to Bioinformatics. Singapore, World Scientific Publishing Company, 2010.

REFERENCES

7. Izadkhah, Habib. Deep Learning in Bioinformatics: Techniques and Applications in Practice. Netherlands, Elsevier Science, 2022.
8. Agapito, Giuseppe, et al. Artificial Intelligence in Bioinformatics: From Omics Analysis to Deep Learning and Network Mining. Netherlands, Elsevier Science, 2022.
9. Data Analytics in Bioinformatics: A Machine Learning Perspective. United States, Wiley, 2021.
10. Michailidis, George, et al. Introduction to Machine Learning and Bioinformatics. United Kingdom, CRC Press, 2008.
11. Zhang, Yanqing, and Rajapakse, Jagath C, Machine Learning in Bioinformatics, Germany, Wiley, 2009.
12. Baldi, Professor Pierre, et al. Bioinformatics, Second Edition: The Machine Learning Approach. India, Bradford, 2001.

COURSE PLAN

Module	Contents	Hours
I	Overview of Machine Learning- Overview of Machine Learning, fitting predictive models to data, Supervised and unsupervised learning, Classification, regression and clustering problems, Loss or cost functions. Parameters and hyperparameters, Training. validation and testing, Inductive bias and the bias variance trade-off, Use of clustering models.	**12**
II	Clustering problems Computational Biology Hierarchical Clustering, Partition Clustering, Overview Model-Based Clustering, k-Means clustering, k-Means clustering algorithm, Advantages, Disadvantages, illustrative example of kMeans clustering, Clustering for creating phylogenetic trees, Using Clustering Approach to Identify Patients' Subtypes, Application of clustering algorithms on gene expression data.	**12**
III	Supervised techniques for Computational Biology- Proteomics Dataset, Data Pre-processing Algorithms, Dimension and Feature Subset Selection, Dimensionality reduction - Principal Component Analysis (PCA), Partial Least Square (PLS), Linear Discriminant Analysis (LDA), Protein Classification, Decision Trees in Bioinformatics, Proteomic Mass Spectra Classification Using Decision Tree Technique.	**12**
IV	Machine-Learning Algorithms for Computational Biology- Machine-Learning Algorithms for Feature Selection from Gene Expression Data, Feature Extraction and Pattern recognition from sequence data, measures of a Feature. Artificial Neural Network (ANN) in Bioinformatics, Genetic Algorithms (GA) in Bioinformatics, Designing ANN for Bioinformatics, ANN in Protein Bioinformatics, Support Vector Machine with Feature Elimination.	**12**
V	Scope of Machine Learning in Computational Biology-Role of Machine Learning in Computational Biology, Creation and analysis of sequence data, Challenges of Machine Learning in Computational Biology, Data Errors, Mean Square Error Generative versus Discriminative, Approximation Versus Explanation, Single Versus Multiple Methods, Future directions of Machine Learning in Computational Biology.	**12**
	Total Hours	**60**

Honour Basket 3: COMPUTER VISION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
CS2H30D	**IMAGE AND VIDEO PROCESSING**	**VAC**	**3**	**1**	**0**		**4**	**2022**

COURSE OVERVIEW

This course enables the learners to understand how digital images are stored and processed. The learners are exposed to different spatial and frequency domain methods for image enhancement, image restoration techniques, morphological operations that could be performed on digital images and also various image and video compression techniques. The course also gives an introduction to the basics of video processing and video segmentation.

Prerequisite: Advanced Computer Graphics, Advanced Concepts in Computer Vision

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Summarize the steps of digital image processing and pixel relationships.	Understand
CO 2	Apply spatial and frequency domain methods for image enhancement.	Apply
CO 3	Apply restoration techniques and morphological operations on digital images.	Apply
CO 4	Compare different methods for digital image and video compression.	Apply
CO 5	Understand the basics of video and video segmentation	Understand

SYLLABUS pocessing

Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering,), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering, , Periodic Noise reduction by frequency domain filtering. Morphological Operations: Erosion, Dilation, Video processing

TEXT BOOKS

4. Gonzalez and Woods , “Digital Image Processing”, 3rd edition , Pearson, 2009.
5. Li, Ze-Nian, Mark S. Drew, and Jiangchuan Liu. “Fundamentals of multimedia”, Pearson Prentice Hall, 2004.
6. Bovik, Alan C. “Handbook of image and video processing”, Academic press, 2010.

REFERENCES

8. David A. Forsyth & Jean Ponce, Computer vision – A Modern Approach, Prentice Hall, 2002.

9. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer.
10. Maheshkumar H Kolekar, “Intelligent Video Surveillance Systems: An Algorithmic Approach”, CRC Press.
11. Francesco Camastra, Alessandro Vinciarelli, “Machine Learning for Audio, Image and Video Analysis: Theory and Applications”, Springer 2015.
12. M. Tekalp ,”Digital video Processing”, Prentice Hall International
13. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRC press Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons,
14. Yao wang, Joem Ostarmann and Ya – quin Zhang, ”Video processing and communication “,1st edition , PHI

COURSE PLAN

Module	Contents	Hours
I	Module – 1 Fundamentals of Image processing: Basic steps of Image processing system, sampling and quantization of an Image, basic relationship between pixels and connectivity. Image Enhancement: Spatial Domain methods - Gray level transformations, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters.	**12**
II	Module -2 Image Transforms: Unitary transforms, 2D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms. Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, homomorphic filtering	**12**
III	Module - 3 Image Restoration: Image degradation/Restoration model, Noise models, Restoration in presence of noise only - spatial filtering, Periodic Noise reduction by frequency domain filtering. Morphological Operations: Erosion, Dilation, Opening, Closing, Hit-or-miss transformation, Boundary extraction.	**2**
IV	Module - 4 Image compression fundamentals – Coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffman coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, JPEG standards.	**12**
V	Module - 5 Video processing: Basics of Video Processing: Analog video, Digital Video. Video segmentation: Introduction to video segmentation, Change detection. COMPUTER SCIENCE AND ENGINEERING(ARTIFICIAL INTELLIGENCE) Video Compression: Introduction to video compression, video compression based on motion compensation, Search for motion vectors, H.261 standard, Transform coding, predictive codingMPEG.	**12**
	Total Hours	**60**

PROGRAM ELECTIVE I

Course Code	Course Name	Cate gory	L	T	P	J	Credit	Year of Introduction
CS1U31C	FOUNDATIONS OF SECURITY IN COMPUTING	PEC	2	1	0		3	2022

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.	**Understand**
CO2	Use the concepts of prime numbers and factorization for ensuring security in computing	**Apply**
CO3	Illustrate the concepts of Linear Congruence, Primitive Roots, Discrete Logarithms and Elliptic Curve Arithmetic	**Apply**
CO4	Summarize the threats and attacks related to computer and program security	**Understand**
CO5	Outline the key aspects of operating system and database security	**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

4. Behrouz A Forouzan, Cryptography and Network Security, 3/e, Tata McGraw-Hill.
5. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5/e, Prentice Hall.
6. 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 requirements of databases, Reliability and integrity, Database disclosure.	8
	Total Hours	**45**

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	J	Credit	Year of Introduction
CS1U31G	Applied Data Science with Python Industry elective	**PEC**	**2**	**0**	**2**		**3**	**2022**

PRE-REQUISITES

Python Basics: Basic Python syntax, Control structures (loops, conditionals), Functions and lambda functions, Basic data structures (lists, dictionaries, tuples, sets Mathematics: Linear Algebra, Calculus, Probability and Statistics, General Computing Knowledge: Familiarity with the command line or terminal, Basic understanding of how databases work, including SQL, Experience with a code editor or an Integrated Development Environment(IDE) like PyCharm or Visual Studio Code.

COURSE OVERVIEW

Applied Data Science with Python course, a comprehensive journey designed to equip you wi the knowledge, skills, and tools necessary to thrive in today's data-driven world. This cours serves as a bridge between theoretical foundations and real-world applications, offering you tl hands-on experience required to tackle actual data challenges.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Make use of Pandas library to effectively process complex datasets.	**Apply**
CO 2	Create effective data visualization using Python libraries	**Apply**
CO 3	Build machine learning and deep learning models using Python libraries	**Apply**
CO 4	Apply Natural Language Processing techniques in data analysis.	**Apply**
CO 5	Develop models using Time series data to solve real world problems	**Apply**

SYLLABUS

Introduction to Data Science and Python ,Data Manipulation with Pandas, Advanced Pandas- Merging, Joining and Concatenating, Pivot Tables, Time Series Analysis in Pandas, Data Visualization with Matplotlib and Seaborn, Seaborn for Statistical Visualization, Advanced Visualization Techniques, Exploratory Data Analysis (EDA),Visual EDA , Introduction to Machine Learning with Scikit-learn, Regression Techniques ,Classification Techniques, Model Evaluation ,Advanced Machine Learning Techniques, Ensemble Methods ,Unsupervised Learning ,Hyperparameter Tuning, Introduction to Deep Learning with TensorFlow/Keras. Understanding Neural Networks, Implementing Neural Networks, Introduction to Convolutional Neural Networks, Natural Language Processing with NLTK and SpaCy, Text Classification and Sentiment Analysis, Named Entity Recognition, Time Series Forecasting with Python, Forecasting Models, Data Science Project.

TEXT BOOKS

5. McKinney, W., 2022. Python for data analysis. " O'Reilly Media, Inc.".
6. Goodfellow, I., Bengio, Y. and Courville, A., 2016. Deep learning. MIT press.
7. Géron, A., 2022. Hands-on machine learning with Scikit-Learn, Keras and TensorFlow. " O'Reilly Media, Inc.".
8. Hapke, H., Howard, C. and Lane, H., 2019. Natural Language Processing in Action: Understanding, analyzing, and generating text with Python. Simon and Schuster.

REFERENCES

1. VanderPla, 2016. Jake. Python Data Science Handbook.
2. Andrew Park, 2021, Data Science for Beginners
3. Müller, A.C. and Guido, S., 2016. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.".
4. Muller, A.C. and Guido, S., 2017. Introduction to machine learning with Python. O'Reilly.

COURSE PLAN

Module	Contents	Hours
I	Introduction to Data Science and Python, What is Data Science, Introduction to Python, Why Python for Data Science?, Data Manipulation with Pandas, Introduction to Pandas ,Data Frames and Series, Basic Operations, Advanced Pandas	8
II	Data Visualization with Matplotlib and Seaborn, Matplotlib Basics ,Seaborn for Statistical Visualization ,Advanced Visualization Techniques Exploratory Data Analysis (EDA) Understanding EDA , Visual EDA -Univariate, Bivariate, and Multivariate Analysis- Correlation and Heatmaps	8
III	Introduction to Machine Learning with Scikit-learn , Understanding Machine Learning Regression Techniques, Classification Techniques Logistic Regression Model Evaluation, Advanced Machine Learning Techniques, Ensemble Methods Unsupervised Learning, Hyperparameter Tuning	10
IV	Introduction to Deep Learning with TensorFlow/Keras, Understanding Neural Networks, Implementing Neural Networks ,Introduction to Convolutional Neural Networks Natural Language Processing with NLTK and SpaCy, Basics of NLP, Text Classification and Sentiment	11

	Analysis, Named Entity Recognition	
V	Time Series Forecasting with Python, Basics of Time Series Analysis Forecasting Models - ARIMA, Exponential Smoothing Practical Data Science Project-Complete End-to-End Project Walkthrough	8
	Total Hours	**45**

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	J	Credit	Year of Introduction
CS2U31A	**CONCEPTS IN COMPUTER GRAPHICS AND IMAGE PROCESSING**	**PEC**	**2**	**1**	**0**		**3**	**2022**

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

Course Outcomes	Description	Level
CO1	Describe the working principles of graphics devices	**Understand**
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	**Apply**
CO3	Demonstrate geometric representations, transformations on 2D & 3D objects, clipping algorithms and projection algorithms	**Apply**
CO4	Summarize visible surface detection methods	**Understand**
CO5	Summarize the concepts of digital image representation, processing and demonstrate pixel relationships	**Apply**
CO6	Solve image enhancement and segmentation problems using spatial domain techniques	**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

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

REFERENCE MATERIALS

5. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics. McGraw Hill, 2001.
6. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill 2019.
7. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
8. 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.	**9**
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.	**9**
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.	**9**
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.	**9**
V	Basic gray level transformation functions - Log transformations, Power-Law transformations, Contrast stretching. Histogram equalization. Basics of spatial filtering - Smoothing spatial filter-	**9**

	Linear and nonlinear filters, and Sharpening spatial filters-Gradient and Laplacian. 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	
	Total Hours	**45**

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	J	Credit	Year of Introduction
CS2U31B	**Object Oriented Programming using Java**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2022**

PRE-REQUISITE: Nil

COURSE OVERVIEW

Aim of the course is to introduce Object oriented concepts in programming. The course introduces Object Oriented Principles, Object Oriented Programming in Java, Exception handling, Event handling, multithreaded programming and graphical user interface programming. The course will enable learners to solve problems by breaking it down to object level while designing software and implementing it using Java.

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Summarize the Basic features and architecture of Java	Understand
CO 2	Construct Object Oriented Design using Unified Modelling Language (UML)	Apply
CO 3	Apply the object-oriented concepts - classes, objects, constructors, data hiding, inheritance, and polymorphism to write Java programs.	Apply
CO 4	Utilize packages & interfaces, input/output streams, files and string-handling mechanisms to develop programs	Apply
CO 5	Utilize exception handling, multithreading and database connectivity to develop java applications.	Apply
CO 6	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, String Handling, Comparison of String Buffer and String, Input/ Output - Reading Console Input, Writing Console Output, Object Streams and Serialization, Working with Files.

Exception Handling, 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).

TEXTBOOKS

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	Hours
I	Approaches to Software Design - Functional Oriented Design, Object Oriented Design, 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 Buzzwords, Java program structure, Comments, Garbage Collection.	**8**
II	Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. 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, 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.	**12**
III	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. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Input/ Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.	**8**
IV	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw,	**9**

	throws and finally. 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, and 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.	
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.	**8**
	Total Hours	**45**

M**ARK 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	J	Credit	Year of Introduction
CS2U31C	**Machine Learning Models and Storage Management**	**PEC**	**2**	**1**	**0**	**0**	**3**	**2022**

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. This course aims to provide the basics for developing deployable machine learning systems. The course helps the students to provide machine learning based solutions to real world problems.

Prerequisite : Nil

COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the basic concepts and techniques of Machine Learning.	**Understand**
CO 2	Demonstrate supervised learning techniques of classification and regression	**Apply**
CO 3	Illustrate the concepts of kernel functions, support vector machines and Markov model.	**Apply**
CO 4	Apply the techniques of clustering and multilayer neural networks.	**Apply**
CO 5	Summarize the process of development of a machine learning model in real-world applications.	**Understand**

SYLLABUS

Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance. Support Vector Machine, Hidden Markov models, Evaluation problem, finding state sequence, Learning model parameters. Clustering Methods Requirements for ML Systems - Iterative process for developing ML systems in production – Data Systems Fundamentals: data sources, data formats , data models, data storage engines and processing – Training data: Sampling techniques, Labelling, Handling class imbalance - Model Development and Training: Evaluating ML Models, Ensembles - Model Offline Evaluation: Baselines, Evaluation Methods – Model Deployment: Batch Prediction vs. Online Prediction, Model Compression, Model Optimization

TEXT BOOKS

1. Ethem Alpaydın, Introduction to Machine Learning (Adaptive Computation and Machine

Learning), MIT Press, 2004.
2. Huyen, Chip. Designing machine learning systems. " O'Reilly Media, Inc.", 2022.

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.

COURSE PLAN

Module	Contents	Hours
I	**Introduction to Machine Learning:** Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis (VC) Dimension. Probably Approximately Learning (PAC), Noise, Learning Multiple classes, Model Selection and Generalization, Dimensionality reduction- Subset selection, Principal Component Analysis.	**9**
II	**Classification:** Cross validation and re-sampling methods- K- fold cross validation, Boot strapping, Measuring classifier performance- Precision, recall, ROC curves. Bayes Theorem, Bayesian classifier, Maximum Likelihood estimation, Density functions, Regression. Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Classification by Regression (CART).	**9**
III	**Kernel Machines:** Support Vector Machine- Optimal Separating hyper plane, Soft-margin hyperplane, Kernel trick, Kernel functions. Discrete Markov Processes, Hidden Markov models, Three basic problems of HMMs- Evaluation problem, finding state sequence, Learning model parameters. Combining multiple learners, Ways to achieve diversity, Model combination schemes, Voting, Bagging, Booting.	**6**
IV	**Unsupervised Learning:** Clustering Methods - K-means, Expectation-Maximization Algorithm, Hierarchical Clustering Methods, Density based clustering. Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation- Multi-Layer Perceptron in Practice – Examples of using the MLP- Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions.	**6**
V	**Designing ML Systems in Production:** Requirements for ML Systems - Iterative process for developing ML systems in production – Data Systems Fundamentals: data sources, data formats , data models, data storage engines and processing – Training data: Sampling techniques, Labelling, Handling class imbalance - Model Development and Training: Evaluating ML Models, Ensembles - Model Offline Evaluation: Baselines, Evaluation Methods – Model Deployment: Batch Prediction vs. Online Prediction, Model Compression,	**15**

	Model Optimization.	
	Total Hours	**45**

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