(AMARAVATI, AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)

B.TECH COMPUTER SCIENCE AND ENGINEERING (ARTIFICIAL INTELLIGENCE) (BTC-AIE)

CURRICULUM 2022

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)

AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

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

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

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES FOR CSE-AI

After completing the B.Tech CSE-AI program, the students will,

1. **PSO1:** Have the ability to apply mathematical and analytical techniques to model complex problems.
2. **PSO2:** Have a strong foundation in programming, together with knowledge of modern languages, tools and technologies needed to build secure, robust software systems.
3. **PSO3:** Have the knowledge of AI and ML techniques required for the design and development of intelligent systems to solve real world problems.

SEMESTER I

Cat.	Code	Title	L T P	Credit
SCI	22MAT110	Mathematics for Computing 1	2 1 3	4
SCI	22PHY106	Computational Physics	2 0 3	3
ENGG	22AIE101	Problem Solving & C Programming	2 1 3	4
ENGG	22AIE102	Elements of Computing Systems 1	2 0 3	3
ENGG	22MAT121	Discrete Mathematics	2 0 3	3
HUM	22ADM101	Foundations of Indian Heritage	2 0 0	2
HUM	19ENG111	Technical Communication	2 0 3	3
HUM	22AVP103	Mastery Over Mind (MAOM)	1 0 2	2
		TOTAL	37	24

SEMESTER II

Cat.	Code	Title	L T P	Credit
SCI	22MAT122	Mathematics for Computing 2	2 1 3	4
ENGG	22AIE111	Object Oriented Programming in Java	2 1 3	4
ENGG	22AIE112	Data Structures & Algorithms 1	2 1 3	4
ENGG	22AIE113	Elements of Computing Systems - 2	2 0 3	3
ENGG	22AIE114	Introduction to Electrical and Electronics Engineering	2 0 3	3
ENGG	22AIE115	User Interface Design	2 0 3	3
HUM	22ADM111	Glimpses of Glorious India	2 0 0	2
		TOTAL	35	23

SEMESTER III

Cat	Code	Title	L T P	Cr
SCI	22MAT220	Mathematics for Computing 3	2 1 3	4
ENGG	22AIE201	Fundamentals of AI	2 0 3	3
ENGG	22AIE202	Operating Systems	2 0 3	3
ENGG	22AIE203	Data Structures & Algorithms 2	2 0 3	3
ENGG	22AIE204	Introduction to Computer Networks	2 0 3	3
ENGG	22AIE205	Introduction to Python	1 0 3	2
ENGG	22BIO201	Intelligence of Biological Systems - 1	2 0 0	2
ENGG		Free Elective 1**	2 0 0	2
HUM		Amrita Values Program	1 0 0	1
		Total	35	23

SEMESTER IV

Cat	Code	Title	L T P	Cr
SCI	22MAT230	Mathematics for Computing 4	2 1 3	4
ENGG	22AIE211	Introduction to Communication & IoT	2 0 3	3
ENGG	22AIE212	Design and Analysis of Algorithms	2 0 3	3
ENGG	22AIE213	Machine Learning	2 0 3	3
ENGG	22AIE214	Introduction to AI Robotics	2 0 3	3
ENGG	22BIO211	Intelligence of Biological Systems 2	2 0 3	3
HUM		Amrita Values Program	1 0 0	1
HUM	19ENV300	Environmental Science		P/F
HUM	19SSK211	Soft Skills I	1 0 3	2
		Total	35	22

SEMESTER V

Cat	Code	Title	L T P	Cr
ENGG	22AIE301	Probabilistic Reasoning	2 0 3	3
ENGG	22AIE302	Formal language and Automata	2 1 0	3
ENGG	22AIE303	Database Management Systems	2 1 3	4
ENGG	22AIE304	Deep Learning	2 0 3	3
ENGG	22AIE305	Introduction to Cloud Computing	2 0 3	3
ENGG		Professional Elective 1*	2 0 3	3
HUM	19SSK301	Soft Skills II	1 0 3	2
HUM	19LIV390	Live-in-Labs I		[3]
		Total	32	21 + [3]

SEMESTER VI

Cat	Code	Title	L T P	Cr
ENGG	22AIE311	Software Engineering (Project-Based)	2 0 3	3
ENGG	22AIE312	Big Data Analytics	2 0 3	3
ENGG	22AIE313	Computer Vision & Image Processing	2 1 3	4
ENGG	22AIE314	Computer Security	2 0 3	3
ENGG	22AIE315	Natural Language Processing	2 0 3	3
ENGG		Professional Elective 2*	2 0 3	3
HUM	19SSK311	Soft Skills III	1 0 3	2
ENGG	19LIV490	Live-in-Labs II		[3]
		Total	34	21 +[3]

SEMESTER VII

Cat	Code	Title	L T P	Cr
ENGG	22AIE401	Reinforcement Learning	2 0 3	3
ENGG		Professional Elective 3*	2 0 3	3
ENGG		Professional Elective 4*	2 0 3	3
HUM	19LAW300	Indian Constitution	1 0 0	P/F
ENGG		Free Elective 2**	3 0 0	3
PRJ	22AIE498	Project Phase 1		6
		Total	19	18

SEMESTER VIII

Cat	Code	Title	L T P	Cr
PRJ	22AIE499	Project Phase 2		10
		Total		10

		Total Credits		162

@'Hands-on' Project-based Lab.
***Professional Elective - Electives categorised under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.**
**** Free Electives - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies).**
***** Live-in-Labs - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.**

PROFESSIONAL ELECTIVES				
Cat	**Code**	**Title**	**L T P**	**Cr**
ENGG	22AIE431	Applied Cryptography	2 0 3	3
ENGG	22AIE432	Network and Wireless Security	2 0 3	3
ENGG	22AIE433	Intrusion Detection and Prevention Systems	2 0 3	3
ENGG	22AIE434	Software Vulnerability Analysis	2 0 3	3
ENGG	22AIE435	Cybercrime Forensics and Digital Forensics	2 0 3	3
ENGG	22AIE436	Distributed System Security	2 0 3	3
ENGG	22AIE437	Medical Image Processing	2 0 3	3
ENGG	22AIE438	Biomedical Signal Processing	2 0 3	3
ENGG	22AIE439	Clinical Information Systems	2 0 3	3
ENGG	22AIE440	Kinematics and Kinetics for Robotics	2 0 3	3
ENGG	22AIE441	Dynamics and Control of Robotics	2 0 3	3
ENGG	22AIE442	Robotic Operating Systems & Robot Simulation	2 0 3	3
ENGG	22AIE443	Underactuated Robotics	2 0 3	3
ENGG	22AIE444	Probabilistic Robotics	2 0 3	3
ENGG	22AIE445	Sensors and Actuators for Robotics	2 0 3	3
ENGG	22AIE446	NLP for Robotics	2 0 3	3
ENGG	22AIE447	Data Driven Control in Robotics	2 0 3	3
ENGG	22AIE448	Introduction to Drones	2 0 3	3
ENGG	22AIE449	Introduction to Digital Manufacturing	2 0 3	3
ENGG	22AIE450	Speech Processing	2 0 3	3
ENGG	22AIE451	Modern & Smart Materials	2 0 3	3
ENGG	22AIE452	Data Driven Material Modelling & Simulation	2 0 3	3
ENGG	22AIE453	Computational Drug Design	2 0 3	3
ENGG	22AIE454	Deep learning in Genomics and Biomedicine	2 0 3	3
ENGG	22AIE455	DNA Sequencing Technologies	2 0 3	3
ENGG	22AIE456	CRISPR Technology	2 0 3	3
ENGG	22AIE457	Full Stack Development	2 0 3	3
ENGG	22AIE458	Mobile Application Development	2 0 3	3
ENGG	22AIE459	User Experience Design	2 0 3	3
ENGG	22AIE460	Software Design Patterns	2 0 3	3
ENGG	22AIE461	Concurrent Programming	2 0 3	3
ENGG	22AIE462	Deep Reinforcement Learning	2 0 3	3
ENGG	22AIE463	Time Series Analysis	2 0 3	3

Table 3 New names for Amrita Value Programmes for UG programmes			
Course Code	Title	L-T-P	Credits
22ADM201	Strategic Lessons from Mahabharatha	1-0-0	1
22ADM211	Leadership from Ramayana	1-0-0	1
22AVP210	Kerala Mural Art and Painting	1-0-0	1
22AVP218	Yoga Therapy and Lessons	1-0-0	1
22AVP212	Introduction to Traditional Indian Systems of Medicine	1-0-0	1
22AVP201	Amma's Life and Message to the modern world	1-0-0	1
22AVP204	Lessons from the Upanishads	1-0-0	1
22AVP205	Message of the Bhagavad Gita	1-0-0	1
22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
22AVP208	Insights into Indian Arts and Literature	1-0-0	1
22AVP213	Traditional Fine Arts of India	1-0-0	1
22AVP214	Principles of Worship in India	1-0-0	1
22AVP215	Temple Mural Arts in Kerala	1-0-0	1
22AVP218	Insights into Indian Classical Music	1-0-0	1
22AVP219	Insights into Traditional Indian Painting	1-0-0	1
22AVP220	Insights into Indian Classical Dance	1-0-0	1
22AVP221	Indian Martial Arts and Self Defense	1-0-0	1
22AVP209	Yoga and Meditation	1-0-0	1

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Code**	**Title**	**L T P**	**Credit**
SCI	**19CHY243**	**Computational Chemistry and Molecular Modelling**	**3 0 0**	**3**
SCI	**19CHY236**	**Electrochemical Energy Systems and Processes**	**3 0 0**	**3**
SCI	**19CHY240**	**Fuels and Combustion**	**3 0 0**	**3**
SCI	**19CHY232**	**Green Chemistry and Technology**	**3 0 0**	**3**
SCI	**19CHY239**	**Instrumental Methods of Analysis**	**3 0 0**	**3**
SCI	**19CHY241**	**Batteries and Fuel Cells**	**3 0 0**	**3**
SCI	**19CHY242**	**Corrosion Science**	**3 0 0**	**3**
PHYSICS				
SCI	**19PHY340**	**Advanced Classical Dynamics**	**3 0 0**	**3**
SCI	**19PHY342**	**Electrical Engineering Materials**	**3 0 0**	**3**
SCI	**19PHY331**	**Physics of Lasers and Applications**	**3 0 0**	**3**
SCI	**19PHY341**	**Concepts of Nanophysics and Nanotechnology**	**3 0 0**	**3**
SCI	**19PHY343**	**Physics of Semiconductor Devices**	**3 0 0**	**3**
SCI	**19PHY339**	**Astrophysics**	**3 0 0**	**3**
Mathematics				
SCI	**19MAT341**	**Statistical Inference**	**3 0 0**	**3**
SCI	**19MAT342**	**Introduction to Game Theory**	**3 0 0**	**3**
SCI	**19MAT343**	**Numerical Methods and Optimization**	**3 0 0**	**3**

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	**Code**	**Title**	**L T P**	**Credit**
HUM	**19MNG331**	**Financial Management**	**3 0 0**	**3**
HUM	**19MNG332**	**Supply Chain Management**	**3 0 0**	**3**
HUM	**19MNG333**	**Marketing Management**	**3 0 0**	**3**
HUM	**19MNG334**	**Project Management**	**3 0 0**	**3**
HUM	**19MNG335**	**Enterprise Management**	**3 0 0**	**3**
HUM	**19MNG338**	**Operations Research**	**3 0 0**	**3**
HUM	**19MEE401**	**Industrial Engineering**	**3 0 0**	**3**
HUM	**19MEE346**	**Managerial Statistics**	**3 0 0**	**3**
HUM	**19MEE347**	**Total Quality Management**	**3 0 0**	**3**

HUM	**19MEE342**	**Lean Manufacturing**	**3 0 0**	**3**
HUM	**19CSE358**	**Software Project Management**	**3 0 0**	**3**
HUM	**19CSE359**	**Financial Engineering**	**3 0 0**	**3**
HUM	**19CSE360**	**Engineering Economic Analysis**	**3 0 0**	**3**
HUM	**19MNG331**	**Financial Management**	**3 0 0**	**3**
HUM	**19CSE362**	**Information Systems**	**3 0 0**	**3**

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS

Cat.	Code	Title	L T P	Credit
HUM	**19CUL230**	**Achieving Excellence in Life - An Indian Perspective**	**2 0 0**	**2**
HUM	**19CUL231**	**Excellence in Daily Life**	**2 0 0**	**2**
HUM	**19CUL232**	**Exploring Science and Technology in Ancient India**	**2 0 0**	**2**
HUM	**19CUL233**	**Yoga Psychology**	**2 0 0**	**2**
HUM	**19ENG230**	**Business Communication**	**1 0 3**	**2**
HUM	**19ENG231**	**Indian Thought through English**	**2 0 0**	**2**
HUM	**19ENG232**	**Insights into Life through English Literature**	**2 0 0**	**2**
HUM	**19ENG233**	**Technical Communication**	**2 0 0**	**2**
HUM	**19ENG234**	**Indian Short Stories in English**	**2 0 0**	**2**
HUM	**19FRE230**	**Proficiency in French Language (Lower)**	**2 0 0**	**2**
HUM	**19FRE231**	**Proficiency in French Language (Higher)**	**2 0 0**	**2**
HUM	**19GER230**	**German for Beginners I**	**2 0 0**	**2**
HUM	**19GER231**	**German for Beginners II**	**2 0 0**	**2**
HUM	**19GER232**	**Proficiency in German Language (Lower)**	**2 0 0**	**2**
HUM	**19GER233**	**Proficiency in German Language (Higher)**	**2 0 0**	**2**
HUM	**19HIN101**	**Hindi I**	**2 0 0**	**2**
HUM	**19HIN111**	**Hindi II**	**2 0 0**	**2**
HUM	**19HUM230**	**Emotional Intelligence**	**2 0 0**	**2**
HUM	**19HUM231**	**Glimpses into the Indian Mind - the Growth of Modern India**	**2 0 0**	**2**
HUM	**19HUM232**	**Glimpses of Eternal India**	**2 0 0**	**2**
HUM	**19HUM233**	**Glimpses of Indian Economy and Polity**	**2 0 0**	**2**
HUM	**19HUM234**	**Health and Lifestyle**	**2 0 0**	**2**
HUM	**19HUM235**	**Indian Classics for the Twenty-first Century**	**2 0 0**	**2**
HUM	**19HUM236**	**Introduction to India Studies**	**2 0 0**	**2**
HUM	**19HUM237**	**Introduction to Sanskrit Language and Literature**	**2 0 0**	**2**
HUM	**19HUM238**	**National Service Scheme**	**2 0 0**	**2**
HUM	**19HUM239**	**Psychology for Effective Living**	**2 0 0**	**2**
HUM	**19HUM240**	**Psychology for Engineers**	**2 0 0**	**2**
HUM	**19HUM241**	**Science and Society - An Indian Perspective**	**2 0 0**	**2**
HUM	**19HUM242**	**The Message of Bhagwad Gita**	**2 0 0**	**2**
HUM	**19HUM243**	**The Message of the Upanishads**	**2 0 0**	**2**
HUM	**19HUM244**	**Understanding Science of Food and Nutrition**	**2 0 0**	**2**

HUM	**19JAP230**	**Proficiency in Japanese Language (Lower)**	**2 0 0**	**2**
HUM	**19JAP2313**	**Proficiency in Japanese Language (Higher)**	**2 0 0**	**2**
HUM	**19KAN101**	**Kannada I**	**2 0 0**	**2**
HUM	**19KAN111**	**Kannada II**	**2 0 0**	**2**
HUM	**19MAL101**	**Malayalam I**	**2 0 0**	**2**
HUM	**19MAL111**	**Malayalam II**	**2 0 0**	**2**
HUM	**19SAN101**	**Sanskrit I**	**2 0 0**	**2**
HUM	**19SAN111**	**Sanskrit II**	**2 0 0**	**2**
HUM	**19SWK230**	**Corporate Social Responsibility**	**2 0 0**	**2**
HUM	**19SWK231**	**Workplace Mental Health**	**2 0 0**	**2**
HUM	**19TAM101**	**Tamil I**	**2 0 0**	**2**
HUM	**19TAM111**	**Tamil II**	**2 0 0**	**2**

SYLLABUS

SEMESTER 1

22MAT110	MATHEMATICS FOR COMPUTING 1	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus, and basic probability theory needed for subsequent study
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind them.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field
- Another goal of the course is to provide the connection between the concepts of linear algebra, differential equations, and probability theory.

Course Outcomes

After completing this course, students will be able to

CO1: Apply the concepts of linear algebra to solve canonical problems.

CO2: Model simple physical systems using ordinary differential equations.

CO3: Solve elementary problems using the concepts of probabilistic theory.

CO4: Analyze elementary problems in linear algebra, ODE, and probabilistic theory with computational techniques.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	1	-	3	-	-	-	2	2	-	2	3	-	-
CO2	3	3	1	-	3	-	-	-	2	2	-	2	3	-	-
CO3	3	3	1	-	3	-	-	-	2	2	-	2	3	-	-
CO4	3	2	2	-	3	-	-	-	2	2	-	2	3	1	-

Syllabus

Unit 1

Basics of Linear Algebra - Linear Dependence and independence of vectors - Gaussian Elimination - Rank of set of vectors forming a matrix - Vector space and Basis set for a Vector space - Dot product and Orthogonality - Rotation matrices - Eigenvalues and Eigenvectors and its interpretation.

Unit 2

Ordinary Linear differential equations, formulation, analytical and Numerical solutions, Impulse Response Computations, Converting higher order into first order equations. Examples of ODE modelling in falling objects, satellite and planetary motion, Electrical and mechanical systems. Multivariate calculus, Taylor series.

Unit 3

Introduction to random variables (continuous and discrete), mean, standard deviation, variance, probability distributions and Monte Carlo Simulations.

Text Books:

- *Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016.*
- *Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*
- *William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.*
- *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*

References:

- *Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.*
- *Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*
- *D. Bertsekas and J. Tsitsiklis, Introduction to Probability, 2nd Edition, Athena Scientific, 2008.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22PHY106	**COMPUTATIONAL PHYSICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course will lay down the basic concepts and techniques needed for verticals such as robotics.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind them.
- It will help the students to perceive the engineering problems using the fundamental concepts in physics.
- Another goal of the course is to provide the connection between the concepts of physics, mathematics, and computational thinking.

Course Outcomes

After completing this course, students will be able to

CO1: Apply the principles of statics to solve elementary problems in physics.

CO2: Apply computational techniques to solve elementary problems in statics.

CO3: Apply computational techniques to solve elementary problems in dynamics.

CO4: Analyze the motion of rigid bodies by applying fundamental principles of dynamics.

CO-PO Mapping

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

Syllabus

Unit 1

Newton's Laws of Motion, Force as 3D Vector, Resolution of Forces, Resultant of Forces.

Unit 2

Equilibrium about a Point, Moment, Couple, Equivalent System, Equilibrium of Rigid Bodies, Degree-of-freedom and Constraints at Supports, Free Body Diagram.

Unit 3

Kinematics of particles, assumptions, Cartesian, Cylindrical and Spherical frames, and motion of particles in them. Translation and rotation of rigid bodies in 2D – Translation and rotation of rigid bodies in 3D.

Unit 4

Kinematics of interconnected rigid bodies– Definition of a linkage – Definition of a mechanism –Four-bar mechanism.

Textbooks

- *Merlam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume 11- dynamics, John Wiley & Sons, New York, 2018.*
- *Hibbeler R. C., Engineering Mechanics: Statics and Dynamics, 11th edition, Pearson Education India, 2017.*
- *Elementary Mechanics Using Matlab – Malthe & Sorenssen – Undergraduate Lecture Notes in Physics, Springer International Publishing, 2015.*
- *Elementary Mechanics Using Python – Malthe & Sorenssen – Undergraduate Lecture Notes in Physics, Springer International Publishing, 2015.*

References Books

- *Beer F.P. and Johnston E.R., Vector Mechanics for Engineers - Volume I - Statics, Volume II - Dynamics, McGraw Hill, New York, 2004.*
- *Shames I. H., Engineering Mechanics, Prentice HaII, New Delhi, 1996.*
- *Statics with Matlab – Marghitu, Dupac& Madsen, Springer – Verlag London 2013.*
- *Advanced Dynamics - Marghitu, Dupac& Madsen, Springer – Verlag London 2013.*

- *Dukkipati R. V., MATLAB: An Introduction with Applications, New Age International; 2010.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE101	**PROBLEM SOLVING & C PROGRAMMING**	**L-T-P-C: 2- 1- 3- 4**

Course Objectives

- To understand the various steps in Program development.
- To understand the basic concepts in C Programming Language.
- To learn how to write modular and readable C Programs.
- To imbibe the problem-solving strategy skill through C programming.

Course Outcomes

After completing this course, students will be able to

CO1: Implement simple algorithms for arithmetic and logical problems to translate pseudocode in C language.
CO2: Evaluate the programs to correct syntax and logical errors.
CO3: Synthesize a complete program using problem solving strategy.
CO4: Apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

CO-PO Mapping

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

Syllabus

Unit 1
Introduction to problem-solving- Computation– expressions, logic; pseudocode vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, the idea of algorithms, problem-solving strategy, Introduction to Programming language concepts, machine language, flowcharts/Pseudo codes, types of compilers and software, pseudocode to programs.

Unit 2
Introduction to C programming, Structure of a C program, Data type, Constants, Variables, Identifiers, Keywords, Declarations, Expressions, Statements, and Symbolic constants.

Input and Output: getchar, putchar, scanf, printf, gets, puts, functions, Pre-processor commands, Preparing and running a complete C program.
Operators and expressions: Arithmetic, unary, logical, bit-wise, assignment and conditional operators, Library functions.
Control statements: if-else, switch, break, continue, while, do-while, for statements, nested loops, goto statements, comma operator.

Unit 3
Functions: Defining and accessing function, passing arguments, function prototypes, recursion, use of library functions, and storage classes.
Arrays: Defining and processing an array, Passing array to a function, multi-dimensional arrays, Sequential search, Sorting arrays, String handling, Operations on strings,
Pointers: Declarations, Passing pointer to a function, Operations on pointers, Pointers and arrays, Arrays of pointers.
Structures and unions: Defining and processing a structure, passing structure to a function, Pointers; and Unions.

Unit 4
File handling: Open, Close, Create, File operations, Unformatted data files, Command line arguments. The Standard C Pre-processor: Defining and calling macros, utilizing conditional compilation, passing values to the compiler, The Standard C Library: Input/Output: fopen, fread, etc, string handling functions, Math functions: log, sin, alike Other Standard C functions.

Textbooks

- *Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.*

Reference Books

- *Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.*
- *Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.*
- *Byron Gottfried. Programming With C. Fourth Edition, McGrawHill; 2018.*
- *Kanetkar, Yashavant, Let us C, BPB publications, 2018.*
- *Brian W. Kernighan and Dennis M. Ritche, The C Programming Language, Pearson Publication, 2015*
- *Problem Solving and Program Design in C, J. R. Hanly and E. B. Koffman, 5th Edition, Pearson Education.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE102	**ELEMENTS OF COMPUTING SYSTEMS 1**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

• The course will expose the students to the basics of Boolean algebra and it will further help them to understand the workings of a modern computer.

• Students will be trained to build a computing system using elementary logic gates such as NAND, AND, OR etc. through simulation software.

Course Outcomes

After completing this course, the students will be able to

CO1: Realize the concept of Boolean Algebra and Digital Logic.
CO2: Implement different combinational and sequential digital logic systems.
CO3: Design the hardware hierarchy of general-purpose computing systems.
CO4: Build a general-purpose computer capable of running stored programs written in the machine language.

CO – PO Mapping

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

Syllabus

Unit 1
Number System-Decimal to Binary Conversion- Negative Numbers- Signed Magnitude Number System- Boolean algebra and Karnaugh Maps-Boolean Logic, -Logic Gates-Introduction to Hardware simulator platforms; Nand ToTetris, -Hardware description language-Realization of basic gates using NAND gate.

Unit 2
Boolean function synthesis-Combinational Logic- Half Adder-Full Adder-Multiplexer (MUX) and demultiplexer (DeMUX) design-ALU and its implementation.

Unit 3
Sequential Logic Design- Memory Elements Computer Architecture: Von-Neumann architecture-Registers-Flip-Flops-RAM, ROM, Program Counter -Hack CPU -Machine Language vs High-level- Basic experiments using machine language.

Text Books:

1. *Noam Nisan and Shimon Schocken, "Elements of Computing Systems", MIT Press, 2012.*
2. *M. Morris Mano, "Digital Design", 5th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi,2014.*
3. *John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.*

Reference Books:

4. *Anil K. Maini, "Digital Electronics", Wiley, 2014.*
5. *Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.*
6. *Donald D.Givone, "Digital Principles and Design", TMH, 2003.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20

Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22MAT121	DISCRETE MATHEMATICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- Familiar various concepts in logic and proof techniques.
- Understand the concepts of various types of relations, partial ordering and equivalence relations.
- Understand the concepts of generating functions and apply to solve the recurrence relations.
- Familiar basic results in number theory and understand it applications in information security.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply the tools and techniques of mathematical reasoning required for computing.
CO2: Apply the concepts of generating functions to solve the recurrence relations.
CO3: Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.
CO4: Apply the formalism of number theory required for computing.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	1
CO2	3	3	2	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	-	1	-
CO4	2	3	2	-	-	-	-	-	-	-	-	-	1	2

Syllabus

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

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

Unit 3
Number Theory: Divisibility and Factorization. Simultaneous linear congruences, Chinese Remainder Theorem. Wilson's Theorem, Fermat's Theorem, pseudoprimes and Carmichael numbers, Euler's Theorem. Arithmetic functions and Quadratic residues.

Textbooks:

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

Reference(s)

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

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22ADM101	**Foundations of Indian Heritage**	**L-T-P-C: 2-0-0-2**

Course Objectives

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

Course Outcomes

After completing this course, students will be able to

CO1: Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education**.**

CO2: Understand the foundational concepts of Indian civilization like *puruśārtha*-s, law of karma and *varṇāśrama*.

CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices**.**

CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga.

CO5: Get guidelines for healthy and happy living from the great spiritual masters

CO-PO Mapping

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

CO5						3	1	3				2		

Syllabus

Unit 1
Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life and vision of holistic education.
Unit 2
Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.
Unit 3
Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

Text Book

- *Cultural Education Resource Material Semester-1*

Reference Book(s)

- *The Eternal Truth (A compilation of Amma's teachings on Indian Culture)*
- *Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.*
- *Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9*
- *My India, India Eternal. Swami Vivekananda. Ramakrishna Mission.*

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

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

19ENG111	**TECHNICAL COMMUNICATION**	**L-T-P-C: 2-0-3-3**

Course Objectives:

- To introduce the students to the fundamentals of mechanics of writing
- To facilitate them with the style of documentation and specific formal written communication
- To initiate in them the art of critical thinking and analysis
- To help them develop techniques of scanning for specific information, comprehension and organization of ideas
- To enhance their technical presentation skills

Course Outcomes: The course will enable the student:

CO1: To gain knowledge about the mechanics of writing and the elements of formal correspondence

CO2: To understand and summarise technical documents

CO3: To apply the basic elements of language in formal correspondence

CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner

CO5: To compose project reports/ documents, revise them for language accuracy and make technical presentations

CO-PO Mapping

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1										3					
CO2				1						2					
CO3										3					
CO4				1						2					
CO5									2	1					

Syllabus

Unit 1

Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers

General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2

Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals

Formal Correspondence: Writing formal Letters

Mechanics of Writing: impersonal passive & punctuation

Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting

Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation

Reading and listening comprehension of technical documents

Mini Technical project (10 -12 pages)

Technical presentations

Text Books & References

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

Evaluation Pattern

Assessment	Internal/External	Weightage (%)

Periodical 1	Internal	10
Periodical 2	Internal	10
*Continuous Assessment (Theory) (CAT)	Internal	10
*Continuous Assessment (Lab) (CAL)	Internal	40
End Semester	External	30

*CA can be Quizzes, Assignments, Projects and Report

SEMESTER II

22MAT122	MATHEMATICS FOR COMPUTING 2	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course student will be able to,

CO1: Apply matrix decomposition techniques to solve elementary problems.

CO2: Apply the concepts of linear algebra and differential calculus to solve elementary optimization problems.

CO3: Analyze data using fundamental techniques of probability.

CO4: Implement the concepts and techniques of linear algebra, optimization and probability for signal and image processing.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO2	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO3	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO4	3	2	1	1	3	-	-	-	2	2	-	2	3	1	1

Syllabus

Unit 1

Gaussian elimination, LU decomposition, Infinite dimensional vector spaces, Fourier Series and Fourier Transform and its properties, Convolution, Vector spaces associated with Matrices, Projection matrix and Regression, Convolution sum, Convolution Integral, Cayley Hamilton theorem, Diagonalizability of matrices, Eigenvalues and Eigenvectors of Symmetric matrices, Eigenvalues and Eigen vectors of A^TA, AA^T, Relationship between vector spaces associated with A, A^TA, $AA^{T,}$ Singular Value Decomposition.

Unit 2

Taylor series expansion of multivariate functions, conditions for maxima, minima and saddle points, Concept of gradient and hessian matrices, Multivariate regression and regularized regression. Theory of convex and non-convex optimization, Newton method for unconstrained optimization. Signal processing with regularized regression.

Unit 3

Random variables and distributions, Expectation, Variance, Moments, Cumulants, Sampling from univariate distribution- various methods, Bayes theorem, Concept of Jacobian, and its use in finding pdf of functions of Random variables (RVs), box-muller formula for sampling normal distribution, Concept of correlation and Covariance of two linearly related RVs.

Text Books:

- *Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*
- *William Flannery, "Mathematical Modeling and Computational Calculus", Vol-1, Berkeley Science Books, 2013.*
- *Stephen Boyd and Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2018.*
- *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*

Reference Books:

- *Stephen Boyd and Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018.*
- *Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*
- *Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE111	**OBJECT ORIENTED PROGRAMMING IN JAVA**	**L-T-P-C: 2- 1- 3- 4**

Course Objectives

- The course will provide an introduction to object-oriented programming.
- It will expose the students to the paradigm of object-oriented programming.
- Students will also be motivated to solve the problems in engineering using the concepts of object-oriented programming.

Course Outcomes
After completing this course, students will be able to

CO1: Represent the problems using objects and classes.
CO2: Implement object-oriented concepts using the Java language.
CO3: Apply the object-oriented concepts to design and visualize programs using UML.
CO4: Implement applications using object-oriented features.

CO-PO Mapping

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

Syllabus

Unit 1:
Introduction: Introduction to Java Language and Runtime Environment, JVM, Bytecode, Object-oriented concepts- Abstraction, Encapsulation, Inheritance and Polymorphism, Basic program syntax, Hello world, Data types, Variables, Operators, Control statements and functions-value types and reference types, The concept of references

Unit 2:
Classes, Objects, and Constructors: Objects in Java, Class file, Constructor functions, Class members and method, Class Instance variables, The Object class, Garbage collector, Method overloading, Constructors, Constructor overloading.
Inheritance and Packages: Basics of Inheritance, Types of Inheritance, Super keyword, Final keyword, Overriding of methods, Applying and implementing interfaces, Packages-create, access and importing packages

Unit 3:
Exception handling and Threading: Introduction to exception handling, Hierarchy of exception, Usage of try, catch, throw, throws and finally, Built-in and user defined exceptions, Threads, Creating Threads, Thread life cycle, Concept of multithreading

Unit 4:
GUI programming with Swing: Applets-Applet class, Delegation event model-events, event sources, event listeners, event classes, mouse and keyboard events, JLabel, JText, JButton, JList, JCombo box.

Textbooks

- *Herbert Schildt, Java: A Beginner's Guide, Tata McGraw-Hill Education, Ninth Edition*

Reference Books

- *Herbert Schildt, Java The Complete Reference, Tata McGraw-Hill Education, Ninth Edition.*
- *Sierra, Kathy, and Bert Bates. Head first java. " O'Reilly Media, Inc.", 2003.*
- *John R. Hubbard, Schaum's Outline of Programming with Java, McGraw-Hill Education, 2004*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE112	**DATA STRUCTURES & ALGORITHMS 1**	**L-T-P-C: 2- 1- 3- 4**

Course Objectives

- This course aims at introducing the concept of data structure hierarchy.
- It will also expose the students to the basic and higher order data structures.
- Further the students will be motivated to apply the concept of data structures to various engineering problems.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply an appropriate data structure for a specified problem.
CO2: Analyze the complexity of algorithms.
CO3: Implement linear data structures to solve different problems.
CO4: Implement non-linear data structures like trees to solve different problems.

CO-PO Mapping

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

Syllabus

Unit 1

Data Structure Hierarchy – primitive and non-primitive, Array data structure, properties and functions, single and multi-dimensional arrays, simple problems, Basics of Algorithm Analysis, big-O notation, notion of time and space complexity, dynamic arrays

Unit 2

Linked List, properties and functions, array implementations, singly linked list, doubly linked list, circular linked list, properties and functions, simple problems

Unit 3

Stack data structure, properties and functions, recursion, expression evaluation, simple problems, Queue data structure, Circular queue, Double ended queue, priority queues, properties and functions, simple problems (Implementation using arrays, LL)

Unit 4
Tree – Binary Tree, Binary Search Tree-– Array and Linked list representation, AVL Tree - union and intersections of tree structures, Complete binary tree, Binary Heap Data Structure-Heap order and Heapsort

Textbooks

- *Alfred V Aho, John E Hopcroft, Jeffrey D Ullman. Data Structures & Algorithms, Pearson Publishers, 2002.*
- *Maria Rukadikar S. Data Structures & Algorithms, SPD Publishers, 2011.*

Reference Books

- *Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Java,Wiley India Edition, Third Edition.*
- *Narasimha Karumanchi, Data Structures and Algorithms Made Easy in Java, CarrerMonk, 2011*
- *Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education, 2002.*
- *Lipschutz Seymour, Data Structures with C (Schaum's Outline Series), McGraw Hill Education India, 2004*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE113	**ELEMENTS OF COMPUTING SYSTEMS – 2**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

• This course is an integrative, project-oriented systems building course.
• The course exposes students to a significant body of computer science knowledge, gained through a series of hardware and software construction tasks.
• These tasks demonstrate how theoretical and applied techniques in AI are used in practice.

Course Outcomes

After completing this course, students will be able to

CO1: Analyze the important components of a MIPS computer system and the basic organization
CO2: Implement low-level programming on the hardware platform
CO3: Develop programs in object-based language ‘Jack’
CO4: Execute experiments related to basic concepts and functions of operating systems and compilers.

CO-PO Mapping

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

Syllabus

Unit 1
Basic Computer Architecture-Instruction set and Machine language-MIPS instructions- add, subtract, bitwise operators, branches- CPI metric- Data path design for single clock.-Assembler

Unit 2
Virtual Machine I: Stack Arithmetic, Background VM Specification Part-1, Implementation and Perspective. Virtual Machine II: Program Control Background, VM Specification Part-2, Implementation, Perspective. High-Level Language: Background, The Jack Language Specification. Writing Jack Applications.Perspective.

Unit 3
Compiler I - Syntax Analysis: Background, Specification, Implementation, Perspective. Compiler II - Code Generation: Background, Specification, Implementation, Perspective. Operating System: Background, the Jack OS Specification, Implementation, Perspective

Textbooks:

- *Nisan, Noam, and Shimon Schocken. The elements of computing systems: building a modern computer from first principles. MIT Press, 2005.*
- *M. Morris Mano Computer System Architecture, Prentice Hall, Third Edition.*

Reference Books:

- *Hennessy, John L., and David A. Patterson. Computer architecture: a quantitative approach. Elsevier, 5th Edition, 2011.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE114 INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course will lay down the basic concepts and techniques of electrical and electronics engineering needed for advanced topics in AI.
- It will help the students to perceive the engineering problems using the fundamental concepts in electrical and electronics engineering.
- Another goal of the course is to provide connection between the concepts of electrical and electronics engineering, mathematics, and computational thinking.

Course Outcomes

After completing this course, students will be able to

CO1: Familiarise the fundamental concepts in electrical and electronics engineering.
CO2: Implement the state-of-the-art computational techniques that can be employed to analyse the structured problems in electrical engineering.
CO3: Realize basic electronic components and circuits using various semiconductor devices
CO4: Implement various circuits applications in the perspective of electronics

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO8	PO 9	PO10	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	-	-	-	3	3	2	2	-	2	-
CO2	3	3	3	3	3	-	-	-	3	3	2	2	2	2	-
CO3	3	3	3	3	3	-	-	-	3	3	2	2	1	2	-
CO4	3	3	3	3	3	-	-	-	3	3	1	1	2	2	-

Syllabus

Unit 1

Fundamental electrical laws-Fundamental circuit elements: charge, voltage, current – Resistance – Ohms law – Kirchhoff's voltage and current law – Energy and power – Series parallel combination of R, L, C components – Voltage divider and current divider rules – Super position theorem – Inductors and capacitors – Impedance and AC sinusoidal signals

Unit 2

Semiconductor materials – PN junction diode – Diode characteristics – Diode applications: Clippers and Clampers – Rectifiers: Half wave, Full wave, Bridge – Zener diode –Introduction to BJT–BJT characteristics and configurations – CE amplifier – Transistor as a switch – Filed effect transistors: MOSFET

Unit 3

Operational amplifiers – Inverting and non-inverting amplifier – Oscillators –Instrumentation amplifier

Textbooks:

1. *Hughes, Edward, John Hiley, Ian McKenzie Smith, and Keith Brown. Hughes electrical and electronic technology. Pearson education, 2005.*
2. *David A. Bell. Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2008.*
3. *Bhattacharya, S. K. Basic Electrical Engineering. Pearson Education India, 2011.*

Reference Books:

- *A. Malvino And D. J. Bates. Electronic Principles, 7th Edition, Tata McGraw - Hill, 2007.*
- *Vincent Del Toro. Electrical Engineering Fundamentals, Prentice Hall of India Private Limited, 2nd Edition, 2003.*
- *Michael Tooley B. A. Electronic circuits: Fundamentals and Applications, 3rd Edition, Elsevier Limited, 2006*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE115	**USER INTERFACE DESIGN**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- Focus in this course is on the basic understanding of user interface design by applying HTML, CSS and Java Script.
- On the completion of the course, students will be able to develop basic web applications
- This course will serve as the foundation for students to do several projects and other advanced courses in computer science

Course Outcomes

After completing this course, students will be able to

CO1: Apply the basics of World Wide Web concepts during web development.
CO2: Develop webpage GUI using HTML5 technology.
CO3: Develop GUI using CSS and Java Script.
CO4: Develop a simple web application using html, CSS and JavaScript.

CO-PO Mapping

PSO/PO / **CO**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	-	-	2	2	-	-	-	-	-	-	-	2
CO2	2	2	2	-	-	-	-	-	-	3	-	-	-	-	-
CO3	2	2	2	-	-	-	-	1	-	3	-	-	-	1	1
CO4	-	2	3	3	3	2	2	3	3	3	2	-	1	2	3
CO5	2	2	3	2	3	-	-	3	2	-	-	-	-	2	3

Syllabus

Unit 1

Introduction to Web – Client/Server - Web Server - Application Server- HTML Basics- Tags - Adding Web Links and Images- Creating Tables-Forms - Create a Simple Web Page - HTML 5 Elements - Media – Graphics.

Unit 2

CSS Basics –Features of CSS – Implementation of Borders - Backgrounds- CSS3 - Text Effects -Fonts -Page Layouts with CSS

Unit 3

Introduction to Java Script –Form Validations – Event Handling – Document Object Model - Deploying an application

Textbooks

- *Kogent Learning Solutions Inc. Html5 Black Book: Covers Css3, Javascript, Xml, Xhtml, Ajax, PhpAndJquery. Second Edition, Dreamtech Press; 2013.*

Reference Books

- *Tittel E, Minnick C. Beginning HTML5 and CSS3 For Dummies. Third edition, John Wiley & Sons; 2013.*
- *Powell TA, Schneider F. JavaScript: the complete reference. Paperback edition, Tata McGraw-Hill; 2012.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22ADM111	**Glimpses of Glorious India**	**L-T-P-C: 2-0-0-2**

Course Objectives

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

Course Outcome

CO1: Get an overview of Indian contribution to the world in the field of science and literature.
CO2: Understand the foundational concepts of ancient Indian education system.
CO3: Learn the important concepts of Vedas and *Yogasutra*-s and their relevance to daily life.
CO4: Familiarize themselves with the inspirational characters and anecdotes from the *Mahābhārata* and *Bhagavad*
Gītā and Indian history.
CO5: Gain an understanding of Amma's role in the empowerment of women.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3	3					2			
CO2						1		3				2			
CO3						3	3	3				2			
CO4						3	3	3				2			
CO5						1		1							

Syllabus

Unit 1

To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

Unit 2

The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit 3

Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

Text Book

- Cultural Education Resource Material Semester-2

Reference Book(s)

- *Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.*
- *The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.*
- *Indian Culture and India's Future. Michel Danino. DK Publications.*
- *The Beautiful Tree. Dharmapal. DK Publications.*
- *India's Rebirth. Sri Aurobindo. Auroville Publications.*

Evaluation Pattern:

Assessment	Internal	End Semester
Periodical 1 (P1)	15	
Periodical 2 (P2)	15	
*Continuous Assessment (CA)	20	
End Semester		50

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

SEMESTER III

22MAT220	MATHEMATICS FOR COMPUTING 3	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course, students will be able to

CO1: Demonstrate the techniques of optimization needed for AI.

CO2: Analyze physical systems using the formalism of partial differential equation.

CO3: Use the tools and techniques of probability theory needed for data analysis.

CO4: Apply modern computational tools and techniques for solving advanced problems in optimization, differential calculus, and probability theory needed for AI.

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	-	-	-	3	2		2	3		3
CO2	3	3	2	3	3	-	-	-	3	2		2	3		2
CO3	3	3	2	3	3	-	-	-	3	2		2	3		3
CO4	3	3	2	3	3	-	-	-	3	2		2	3		3

Syllabus

Unit 1
Direct methods for convex functions, sparsity inducing penalty functions. Constrained Convex Optimization problems, Krylov subspace, Conjugate gradient method, formulating problems as LP and QP, support vector machines, solving by packages (CVXOPT), Lagrangian multiplier method, KKT conditions. Introduction to alternating direction method of multipliers (ADMM) - the algorithm. Applications in signal processing, pattern recognition and classification.

Unit 2
Introduction to PDEs. Formulation and numerical solution methods (Finite difference and Fourier) for PDEs in Physics and Engineering.

Unit 3
Inequalities of statistics, Multivariate Gaussian and weighted least squares, Markov chains, Markov decision process.

Textbooks / References

Gilbert Strang, "Differential Equations and Linear Algebra Wellesley", Cambridge press, 2018.

Gilbert Strang, Wellesley, "Linear Algebra and learning from data", Cambridge press, 2019.

Stephen Boyd and Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2018.

Stephen Boyd and, Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE201	**FUNDAMENTALS OF AI**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- To introduce classical AI and rational intelligent agents.
- To introduce techniques for problem solving by search and adversarial games.
- To introduce constraints, logic, and inference techniques
- To introduce planning, acting, and multi-agent systems.
- To introduce knowledge-representation and reasoning.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse different elements of an AI system.

CO2: Apply elementary principles of AI for problem solving and search

CO3: Apply constraints and logic for intelligent systems

CO4: Apply knowledge representation and reasoning for defining intelligent systems,

CO-PO Mapping

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

Syllabus:

Unit 1

History and Foundations of AI, Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents.

Unit 2

Problem Solving by Search: Uninformed and Informed Search Strategies, Heuristic Functions; Adversarial Search: Games, Optimal Decisions in Games, Alpha-Beta Pruning

Unit 3

Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining

Unit 4

Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.

Textbooks/ References:

Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.

Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.

Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE202	**OPERATING SYSTEMS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course gives an insight to the important problems in operating system design and implementation.
- This course helps the students to understand the operating system responsibilities like sharing resources, files, memory and process scheduling.
- This course covers the major components of most operating systems and the trade-offs between performance and functionality in the design and implementation of an operating system.
- In this course, emphasis will be given to three major OS subsystems: process management, memory management, and file systems; and on operating system support for distributed systems.

Course Outcomes
After completing this course, the students will be able to

CO1: Apply system calls to implement basic OS functionalities.
CO2: Apply the algorithms for resource management and scheduling.
CO3: Apply semaphores and monitors for synchronization problems.
CO4: Implement memory management schemes.

CO-PO Mapping

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

Syllabus

Unit 1
Operating systems, structure, operating systems services, system calls. Process and Processor management: Process concepts, process scheduling and algorithms, threads, multithreading. CPU scheduling and scheduling algorithms

Unit 2
Process synchronization, critical sections, Deadlock: Shared resources, resource allocation and scheduling, resource graph models, deadlock detection, deadlock avoidance, deadlock prevention algorithms, mutual exclusion, semaphores, monitors, wait and signal procedures. Memory management: contiguous memory allocation, virtual memory, paging, page table structure, demand paging, page replacement policies, thrashing, segmentation, case study.

Unit 3
Disk scheduling algorithms and policies, File management: file concept, types and structures, directory structure, Case study on Unix (about process management, Thread management and Kernel) and Mobile OS – iOS and Android – Architecture and SDK Framework, Media Layer, Services Layer, Core OS Layer, File System)

Textbooks/References

Silberschatz and Galvin, "Operating System Concepts", 9th Edition, Wiley India, 2009.
Tannenbaum A S, "Modern Operating Systems", Prentice Hall India, 2003.
W. Stallings, "Operating Systems: Internals and design Principles", Pearson Ed., LPE, 6th Ed., 2009
M.J. Bach, "Design of Unix Operating system", Prentice Hall, 1986

Evaluation Plan

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE203	**DATA STRUCTURES & ALGORITHMS 2**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course helps students to implement and understand space and time optimizing structures and learn their behaviours
- This course helps students to comprehend multidimensionality in memory structures
- This course helps students to understand the geometric organization of data
- This course provides an overview of space-building and immutability in functional data structure
- This course gives an introduction to graphical structures and use them in solving problems

Course Outcomes
After completing this course, the students will be able to

CO1: Design suitable data structures for problem-solving.
CO2: Use appropriate data structures for problem-solving scenarios.
CO3: Apply the interoperability of data structures to solve problems.
CO4: Visualize multidimensional geometry of data structure and concurrency.

CO-PO Mapping

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

Syllabus

Unit 1
Graphs- Representations of graphs, Adjacency and Incidence matrices, Adjacency List, Dynamic Graphs and persistence - Sparse Matrices- Key Value and Structural implementations, Scalability and data driven parallelism, Block and band matrices. Generalized Matrix and Vector interface. Standard implementations in Numpy (Python) and NDArray (Java) - Temporal manipulation and persistence

Unit 2
Functional data structures, ConsList, immutable Set, Immutable Maps, Sorting immutable linear structures (functional sort). Map and Reduce Operations on Sequences

Unit 3
Retroactive structures and operations – Geometric structures- Point location and sweeping, Orthogonal Range searches and fractional cascading in 2D and 3D. -Higher data structures - Tries and inverted Tries- Radix Sort, Higher Hash functions, SHA256, Chaining of Hash Lists (Blockchain) and change detection, Merkel trees- Distributed bitwise representations and Fusion trees - large string structures (Google and DNA problems)

Textbooks/References

Mehlhorn, Kurt, Peter Sanders, and Peter Sanders. Algorithms and data structures: The basic toolbox. Vol. 55. Berlin: Springer, 2008.

Bhim P Upadhyaya, Data Structures and Algorithms with Scala. Springer International Publishing, 2019.

Aho, Alfred V. "Data Structures and Algorithms, Addison-Wesley." Reading, Mass. (1983).

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition (3rd ed.). The MIT Press

Evaluation Plan

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE204 INTRODUCTION TO COMPUTER NETWORKS L-T-P-C: 2-0-3- 3

Course Objectives

- This course helps students to understand the fundamental networking concepts and standards.
- This course helps students to understand the function of TCP/IP layers and the protocols involved.
- This course helps students to understand the configuration of different networks and routing using simulator/emulator.
- This course provides an overview of internet of things, its various applications, and their implementation using simulator/emulator/Raspberry-PI.
- This course gives an introduction to the concepts of software defined networks and its applications.

Course Outcomes
After completing this course, the students will be able to

CO1: Analyse the requirements for a given organizational structure to select the most appropriate networking architecture and technologies.
CO2: Analyse the working of protocols in the internet protocol stack for network applications.
CO3: Configure a router using simulator/emulator.
CO4: Implement IoT applications using simulator/emulator/Raspberry Pi.

CO-PO Mapping

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

Syllabus

Unit 1
Basic concepts of computer networks, Internet-The Network Edge, the Network Core, Network Topology, Types of Networks. Circuit switched networks vs packet switched network, Delay, Loss, and Throughput in Packet Switched Networks. OSI layer stack, Introduction to applications in networking, protocols in the context of the Internet protocol stack. Internet standards and organization

Unit 2
Application Layer – Protocols in Web and Email applications, Peer-to-Peer Applications. Transport Layer – connection-oriented and connectionless service, protocols, and socket programming. Network Layer – Internet Protocol, Host Addressing for subnets, Routing and Forwarding principles, Router configuration. Configuration and implementation of local area networks and intranets in simulator or emulator. Data link and Physical layer concepts for wired and wireless network

Unit 3

Internet of Things – Components like controllers, services, Fog and cloud computing, Applications. Configuration and implementation of IoT applications in simulator or emulator or real time hardware devices like Raspberry Pi. Introduction to Software Define Networks, Mininet and OpenFlow.

Textbooks/References

Kurose, James F. Computer networking: A top-down approach featuring the internet, 3/E. Pearson Education India, 2005.
Behrouz A Forouzan, and G. Hill. Data Communications and Networking, by Behrouz, 2006.
Rick Golden, Raspberry Pi Networking Cookbook – Second Edition, 2017

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE205	**INTRODUCTION TO PYTHON**	**L-T-P-C: 1- 0- 3- 2**

Course Objectives

- To acquire programming skills in core Python.
- To understand how to write functions and pass arguments in Python.
- To develop fundamental understanding of how to build and package Python modules for reusability.
- To develop program in python to read and write files.

Course Outcomes

After completing this course, students will be able to

CO1: Solve problems using Python conditionals and loops.

CO2: Apply Python functions and function calls to solve problems.

CO3: Apply Python data structures to represent complex data.

CO4: Develop Python Packages for reusability.

CO-PO Mapping

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

CO1	3	3	2	2	3	-	-	-	3	2	3	3	1	1	1
CO2	3	3	3	3	3	-	-	-	3	2	3	3	1	1	1
CO3	3	2	3	3	3	-	-	-	3	2	3	3	1	1	1
CO4	3	2	3	3	3	-	-	-	3	2	1	3	1	1	1

Syllabus

Introduction to Python Control Statements-List, Ranges & Tuples in Python-Python Dictionaries and Sets-Input and Output in Python-Python built in function-Python Object Oriented-Exceptions-Python Regular Expressions-Python Multithreaded Programming-Using Databases in Python-Regular Expression -Thread Essentials-Web Scraping in Python-Data Science Using Python-Graphical User Interface-Django Web Framework in Python Interface of python with an SQL database-Connecting SQL with Python-Performing Insert, Update, Delete Queries using Cursor-NumPy-Pandas and data frame operations on Toyota Corolla dataset-Data visualization; matplotlib, seaborn libraries-Python Libraries

Textbooks

Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

References

Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.

Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.

https://www.python.org/,numpy.org

Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

David Beazley, Brian Jones., "Python Cookbook", Third Edition, Orelly Publication, 2013, ISBN 978-1449340377

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 1)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22BIO201	**INTELLIGENCE OF BIOLOGICAL SYSTEMS 1**	**L-T-P-C: 2- 0- 0- 2**

Course Objectives

- Understanding the basic concepts about biomolecules, cell division, central dogma of the cell, mutations and evolutionary patterns
- Knowledge about biological databases, bacterial genomes and its hidden message.
- Understanding the mechanism of DNA methylation in circadian rhythm
- Application of statistical methods in sequence analysis and motif finding

Course Outcomes

After completing this course, the students will be able to

CO1: Apply the cellular structure and biophysical process for creating engineered models.

CO2: Incorporate the application of molecular mechanisms to build advanced computational pipelines.

CO3: Apply statistical estimation and test of significance techniques for Motifs and to learn python for using biological databases.

CO4: Apply chaos model to represent DNA Sequences.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	1	1	3	2	2		3	2		3	2	1	
CO 2	1	1	1	1	3	2	2		3	2		3	1	1	
CO 3	1	3	2	2	3	2	2		3	2		3	2	1	
CO4	2	1	2	3	-	1	1		3	2		2	1	1	

Syllabus

Unit 1

Classification of Biomolecules Cell division: Mitosis and Meiosis; Central Dogma of the cell: Replication, Transcription, Translation, Protein Synthesis; Genetic Variants of Evolutionary Patterns: Mutations and Polymorphisms.

Unit 2

Introduction to biological databases-Hidden messages in the genome – Finding Replication Origins - Frequent words in Vibrio cholera – Encodings in DNA to maintain circadian rhythm Basics of Probability-Probability Distributions.

Unit 3

Statistics-Statistical Estimation and Inference of Sequence Analysis in Matlab -and Python – Simple values, names, expression, module, collection, sequences, mapping and expression feature. Hunting for Regulatory Motifs - Scoring Motifs - Motif Search – Greedy & Randomized Motif Search – Gibbs Sampling-Chaos representation - DNA sequences comparison of related viruses.

Textbooks/References

Gabi Nindl Waite, Lee R Waite, Applied Cell and Molecular Biology for Engineers, McGraw Hill Publishers, 2007.

Phillip Compeau & Pavel Pevzner, Bioinformatics algorithm, An active learning Approach Vol.1. and Vol. 2 , 2015.

George M. Malascinski, Freifelder's Essentials of Molecular Biology, 4th Edition, Jones and Bartlett Student Edition, 2015.

DM.Vasudevan, Sreekumari S, Kannan Vaidyanathan, Textbook of Biochemistry for Medical Students (As Per Revised MCI Curriculum),9th Edition, Jaypee Publishers, 2019.

David Nelson, Michael M Cox, LeningerPrinciples of Biochemistry, 8th Edition, Macmillan, 2021.

Evaluation pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 1)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

AMRITA VALUES PROGRAMME

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Course Outcomes

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata

CO2: Enabling students to importance offighting*adharma* for the welfare of the society through Sabha and Vanaparva.

CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishmaparvas.

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, SauptikaParvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and SwargarohanaParvas.

CO-PO Mapping

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

CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-	
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-	
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-	
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-	
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-	

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World
Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

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

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

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

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

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting

Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability

Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma'swords "it is a big step in restoring the lost harmony of nature".

Benefits of Indian Medicinal Systems

Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India

India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Únity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

TEXT BOOKS/REFERENCES:

1. Rajagopalachari. C, *The Ramayana*

Valmiki, *The Ramayana*, Gita Press

SEMESTER IV

22MAT230	MATHEMATICS FOR COMPUTING 4	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.

- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course student will be able to,

CO1: Demonstrate the techniques of linear algebra needed for AI.

CO2: Apply the tools and techniques of optimization to analyze physical systems.

CO3: Apply the principles of statistics to perform data analysis.

CO4: Apply modern computational tools and techniques for solving advanced problems in linear algebra, optimization, and statistics needed for AI.

CO-PO Mapping

PO/ PSO	PO1	PO 2	PO 3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	---	---	---	3	2	---	3	3	---	3
CO2	3	3	2	3	3	---	---	---	3	2	---	3	3	---	3
CO3	3	3	2	3	3	---	---	---	3	2	---	3	3	---	3
CO4	3	3	2	3	3	---	---	---	3	2	---	3	3	---	3

Syllabus

Unit 1

Linear Algebra-4

Special Matrices: Fourier Transform, discrete and Continuous, Shift matrices and Circulant matrices, The Kronecker product, Toeplitz matrices and shift invariant filters, Graphs and Laplacians and Kirchhoff's laws, Clustering by spectral methods and K-means, Completing rank one matrices, The Orthogonal Procrustes Problem, Distance matrices.

Unit 2

Calculus-4

Optimization methods for sparsity: Split algorithm for L2+ L1, Split algorithm for L1 optimization, Augmented Lagrangian, ADMM, ADMM for LP and QP, Matrix splitting and Proximal algorithms, Compressed sensing, and Matrix Completion.

Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent, and ADAM (adaptive methods), Loss function and learning function.

Unit 3

Probability and statistics - 4

Basics of statistical estimation theory and testing of hypothesis.

Textbooks / References

Gilbert Strang, Linear Algebra and learning from data, Wellesley, Cambridge press, 2019.

Bradley Efron , Trevor Hastie, Computer Age Statistical Inference, Algorithms, Evidence and Data Science.

Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2018.

Stephen Boyd , Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, Cambridge University Press, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE211 INTRODUCTION TO COMMUNICATION & IoT L-T-P-C: 2- 0- 3- 3

Course Objective

1. The course will expose the students to basics of communication systems
2. This course will realize communication experiments using various software defined radio systems.
3. The course provides an understanding on the basics of Internet of Things, architecture and its protocols.

Course Outcomes

After completing this course student will be able to,

CO1: Familiarise the basic concepts of communication systems
CO2: Realise various communication systems using software defined radio systems.
CO3: Familiarise basics of Internet of Things and its architecture
CO4: Interface I/O devices and communication modules.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to signals - types and characteristics; Introduction to communication systems: Wired and Wireless communication systems – Modulations: AM, FM, PM - Digital modulation and de-modulation techniques: ASK, FSK, BPSK and QAM – OFDM - MATLAB and GNURADIO for Communication system experiments.

Unit 2

Introduction to IoT - Architectural overview- Design principles- IoT Applications- M2M and IoT Technology Fundamentals.

Unit 3

Elements of IoT: Hardware components, Communication Technologies, Sensing, Actuation, I/O interfaces Software Components- Programming APIs for communication protocols-MQTT, Zigbee, Bluetooth, CoAP, UDP, TCP.

Text books/ Reference Books:

Boylestad, Robert L., and Louis Nashelsky. Electronic devices and circuit theory. Prentice Hall, 2012.
Qasim Chaudhari, Wireless Communications from the Ground Up: Fundamentals of Digital Communication Systems, Createspace Independent Publishers, 2016
Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A hands on Approach", University Press
Herrero, Rolando. Fundamentals of IoT Communication Technologies. Springer International Publishing, 2022.
Dr SRN Reddy, Rachit Thukral and Manasi Mishra," Introduction to Internet of Things": A practical Approach" ETI Labs
The Internet of Things: Applications and Protocols, Wiley publications. Author(s): Oliver Hersent, David Boswarthick, Omar Elloumi

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE212	**DESIGN AND ANALYSIS OF ALGORITHMS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course helps students to impart various design techniques for formulation of algorithm.
- This course helps students to understand basic categories of algorithms.
- This course helps students to understand and apply analysis of space and time complexity of algorithms and understand concept of growth rate.
- This course helps students to deliver standard notations and representations of algorithmic complexity and known complexities.
- This course helps students to comprehend basic complexity classes.
- This course helps students to acquaint with will know tractable and intractable problems and map solutions to it.

Course Outcomes

After completing this course, the students will be able to

CO1: Develop skills for analyzing algorithmic strategies.
CO2: Apply appropriate algorithmic technique for a given problem.
CO3: Implement standard algorithms on arrays, strings, trees and graph.
CO4: Analyse the nature of known classes of tractable or intractable problem.

CO-PO Mapping

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

Syllabus

Unit 1
Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and growth rate- Empirical analysis – Recursive and non-Recursive Templates. Brute Force: Exhaustive Search and String Matching, Divide and Conquer Methodology: Binary Search – Merge sort – Quick sort – Heap Sort – Multiplication of Large Integers.

Unit 2
Dynamic programming: Principle of optimality – Coin changing problem, Computing a Binomial Coefficient – Floyd's algorithm – Multi stage graph – Optimal Binary Search Trees – Knapsack Problem and Memory functions. Greedy Technique: Container loading problem – Huffman Trees. Iterative methods: The Simplex Method – The Maximum-Flow Problem – Maximum Matching in Bipartite Graphs, Stable marriage Problem, Measuring Limitations: Lower – Bound Arguments – P, NP, NP- Complete and NP Hard Problems.

Unit 3
Backtracking – n-Queen problem – Hamiltonian Circuit Problem – Subset Sum Problem, Branch and Bound – LIFO Search and FIFO search – Assignment problem – Knapsack Problem – Travelling Salesman Problem, Approximation Algorithms for NP-Hard Problems – Travelling Salesman problem – Knapsack problem revisited.

Textbooks/References
Jeffrey McConnell, Analysis of algorithms. Jones & Bartlett Publishers, 2nd Revised edition, 2007.
Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012.
Harsh Bhasin, Algorithms Design and Analysis, Oxford university press, 2016

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE213	MACHINE LEARNING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course dives into the basics of Machine learning.
- This course will enable the students to work with various types of data and its pre-processing techniques.
- The students will learn about Supervised and Unsupervised Learning.
- The students will enrich themselves with hands-on experience to implement various machine learning algorithms.

Course Outcomes

After completing this course, students will be able to

CO1: Apply pre-processing techniques to prepare the data for machine learning applications
CO2: Implement supervised machine learning algorithms for different datasets
CO3: Implement unsupervised machine learning algorithms for different datasets
CO4: Analyze the error to improve the performance of the machine learning models

CO-PO Mapping

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

Syllabus

Unit 1
Introduction to Machine Learning – Data and Features – Machine Learning Pipeline: Data Preprocessing: Standardization, Normalization, Missing data problem, Data imbalance problem – Data visualization - Setting up training, development and test sets – Cross validation – Problem of Overfitting, Bias vs Variance - Evaluation measures – Different types of machine learning: Supervised learning, Unsupervised learning, Reinforcement learning, Generative Learning and adversarial learning.

Unit 2
Supervised learning - Regression: Linear regression, logistic regression – Classification: K-Nearest Neighbor, Naïve Bayes, Decision Tree, Random Forest, Support Vector Machine, Perceptron, Error analysis.

Unit 3
Unsupervised learning – Clustering: K-means, Hierarchical, Spectral, subspace clustering, Gaussian Mixture Model, Hidden Markov Model, Parameter Estimation: MLE and Bayesian Estimate, Expectation Maximization, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis.

Unit 4
Introduction to Neural Networks, Reinforcement learning and generative learning.

Text Books
Andrew Ng, Machine learning yearning, URL: http://www. mlyearning. org/(96) 139 (2017).
Kevin P. Murphey. Machine Learning, a probabilistic perspective. The MIT Press Cambridge, Massachusetts, 2012.
Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010

References

Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. Wiley, Second Edition;2007
Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE214	**INTRODUCTION TO AI ROBOTICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- To provide an introductory understanding of robots and its components.
- To introduce different paradigms used in AI robotics.
- To introduce the mathematical concepts needed for understanding basic robotic system operation.
- To introduce kinematics and its application in robotic manipulators.

Course Outcomes

After completing this course student will be able to,

CO1: Analyse a robotic system using different paradigms of AI robotics.
CO2: Apply mathematical concepts to represent the position and orientation of robotic systems.
CO3: Perform the forward and inverse kinematics of canonical robotic systems.
CO4: Simulate robotic systems using state-of-the-art computational platforms.

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	3	2	1	2	2	2	3	3	3	3	3	2	3
CO 2	3	3	2	2	3	-	-	-	3	3	-	3	3	1	3
CO 3	3	3	2	2	3	-	-	-	3	3	-	3	3	1	3
CO 4	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3

Syllabus

Unit 1

Introduction to robots – Brief History – Types of robots – Teleoperation.

Unit 2

Attributes of the hierarchal paradigm - Attributes of the reactive paradigm – Biological foundations of the reactive paradigm – Common sensing techniques for reactive robots – Attributes of hybrid paradigm.

Unit 3

Mathematical representation of robots – Position and orientation of rigid bodies – Rotation and Orientation – Quaternions and other rotation representations - Transformation Matrix

Unit 4

D-H parameters – Forward and inverse kinematics of robot manipulators.

Text Book /Reference Books

'Robotics, Vision & Control', P. Corke, 2nd edition, Springer, 2011
'Robot Modeling and Control', M.W. Spong, S. Hutchinson and M. Vidyasagar, Wiley, 2006
'Robotics: Fundamental Concepts & Analysis', A. Ghosal, Oxford University Press, Ninth Edition, 2006
'Introduction to Robotics', T. Bajd, M. Mihelj and M. Munih, Springer Briefs in Applied Sciences and Technology, 2013
'Introduction to AI Robotics', Robin Murphy, MIT Press, 2000

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22BIO211	**INTELLIGENCE OF BIOLOGICAL SYSTEMS 2**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- Application of statistics to interpret biological sequence analysis.
- Application of programming to compare biological sequences.
- Evaluation of algorithms in antibiotic sequencing.
- Evaluation of statistical models in Bioinformatics.

Course Outcomes

After completing this course, the students will be able to,

CO1: Apply Dynamic Programming in Sequence Alignment.
CO2: Apply Brute Force Method in Sequence Analysis.
CO3: Apply Graph Theory in Genome Assembly.
CO4: Apply Deep Learning in Bioinformatics.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	1	1	3	2		3		2		3	2	1	
CO 2	1	1	1	1	3	2		3		2		3	1	1	
CO 3	1	3	2	2	3	2		3		2		3	2	1	
CO4	2	1	2	3		1		3		2		2	1	1	

Syllabus

Unit-1

Antibiotics Sequencing – Shattering into pieces – Brute force algorithm for Cyclopeptide Sequencing – Comparison of biological sequences – Cracking the Non-Ribosomal Code – Introduction to Sequence Alignment – Introduction to Dynamic Programming, building a Manhattan-like graph - Mass Spectrometry- From 20 to more than 100 Amino Acids

Unit-2

Introduction - Assembling Genomes using Graph algorithms - String reconstruction problem – String reconstruction as a walk in the overlap graph – Gluing nodes – de Bruijn graphs – the seven bridges of Konigsberg Euler's theorem– Eulerian Cycle – Assembling genomes from read-pairs –Introduction to deep-learning in bioinformatics.

Textbooks/References

Jin Xiong , Essential Bioinformatics , Cambridge University Press, 2006.

Gerald Karp, Chapter 15- Cell Signaling and Signal Transduction: Communication Between Cells, In Cell and Molecular Biology: Concepts and Experiments, 7e, Wiley, 2013.

Phillip Compeau & Pavel Pevzner, Bioinformatics algorithm, An active learning Approach Vol.1. and Vol. 2 , 2015.

Karthik Raman, an Introduction to Computational Systems Biology (Systems Level Modeling of Cellular Networks), CRC Press, 2021.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

AMRITA VALUES PROGRAMME L-T-P-C: 1- 0-0 -1

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

Course Outcomes

CO1: Understanding the impact of *itihasas* on Indian civilization with a special reference to the *Adiparva* of Mahabharata

CO2: Enabling students to importance offighting*adharma* for the welfare of the society through Sabha and Vanaparva.

CO3: Understanding the nuances of dharma through the contrast between noble and ignoble characters of the epic as depicted in the Vana, Virata, Udyoga and Bhishmaparvas.

CO4: Getting the deeper understanding of the Yuddha Dharma through the subsequent Parvas viz., Drona, Karna, Shalya, SauptikaParvas.

CO5: Making the students appreciative of spiritual instruction on the ultimate triumph of dharma through the presentations of the important episodes of the MB with special light on Shanti, Anushasana, Ashwamedhika, Ashramavasika, Mausala, Mahaprasthanika and SwargarohanaParvas.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	2	2	3	3	3	-	3	-	-	
CO2	-	-	-	-	-	3	3	3	3	2	-	3	-	-	
CO3	-	-	-	-	-	3	2	3	3	3	-	3	-	-	
CO4	-	-	-	-	-	3	-	3	3	3	-	3	-	-	
CO5	-	-	-	-	-	3	-	3	3	2	-	3	-	-	

Courses offered under the framework of Amrita Values Programmes I and II

Message from Amma's Life for the Modern World

Amma's messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma's guidance and She teaches us the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana

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

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

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

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

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda's Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji's life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, AdiShankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri RamanaMaharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts, Music, Dance, Theatre.

Yoga and Meditation
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali's Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

Kerala Mural Art and Painting
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

Course on Organic Farming and Sustainability
Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam' is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma's words "it is a big step in restoring the lost harmony of nature ".

Benefits of Indian Medicinal Systems
Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

Traditional Fine Arts of India
India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is 'Unity in Diversity" and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.

Science of Worship in India
Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

TEXT BOOKS/REFERENCES:

1. Rajagopalachari. C, *The Ramayana*

2. Valmiki, *The Ramayana*, Gita Press

19ENV300	ENVIRONMENTAL SCIENCE	P/F

Course Objectives

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

Course Outcomes

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

CO – PO Mapping

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

Syllabus
Unit 1

Over view of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related International conventions and treaties and regulations – Overpopulation – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

Unit 2
Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and

regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land, thermal, noise).

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

Text Book(s)
R. Rajagopalan,"Environmental Studies – From Crisis to Cure", Oxford University Press, 2005, ISBN 0-19-567393-X.

Reference(s)
G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.
Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

19SSK211	**SOFT SKILLS I**	**L-T-P-C: 1-0-3-2**

Course Outcome

CO 1 - Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.

CO 2 - Soft Skills: Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.

CO 3 - Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.

CO 4 – Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively.

CO 5 - Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.

CO 6 – Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

CO-PO Mapping:

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

CO4										3		3			
CO5										3		3			
CO6									3	3		3			

Soft skills and its importance: Pleasure and pains of transition from an academic environment to work - environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, Self-motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words. Listening skills: The importance of listening in communication and how to listen actively.

Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM &HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptogrithms.

TEXTBOOKS

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa& Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quantitative Aptitude by R. S. Aggarwal,S. Chand
Quantitative Aptitude – AbijithGuha, TMH.
Quantitative Aptitude for Cat - Arun Sharma. TMH.

REFERENCES:

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER V

22AIE301	PROBABILISTIC REASONING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course will lay down the basic concepts and techniques of probabilistic reasoning.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of probabilistic reasoning required for AI.

Course Outcomes

After completing this course student will be able to,

CO1: Create probabilistic models pertinent to represent uncertain knowledge.

CO2: Apply the formalism of Bayesian and Markov Networks to solve real world problems.

CO3: Apply tools and techniques of probabilistic reasoning for complex decision making.

CO4: Apply modern computational tools to build probabilistic models.

CO-PO Mapping

PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	3	2	2	3	3	2	3
CO2	3	3	3	3	3	-	-	-	3	2	2	3	3	2	3
CO3	3	3	3	3	3	-	-	-	3	2	2	3	3	2	3
CO4	3	3	3	3	3	-	-	-	3	2	2	3	3	2	3

Syllabus

Uncertain Knowledge Representation, Introduction to Bayesian Networks (BNs), Representation Learning in Bayesian Networks, Inference in Bayesian Networks, Exact and Approximate Inference, Markov Networks, Message Passing, Learning in Markov Networks, Hidden Markov Models, Markov Random Fields (MRF), Markov Chain-Monte Carlo Method, Decision Networks.

Text Books / Reference Books

'Artificial Intelligence: A modern Approach', S J Russell and P Norvig, Pearson (3rd edition), 2010.

'Machine Learning: A Probabilistic Perspective', Kevin Murphy and Francis Bach, Penguin Publishers, 2012

Probabilistic graphical models: principles and techniques. Koller, Daphne, and Nir Friedman. MIT press, 2009.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE302	FORMAL LANGUAGE AND AUTOMATA	L-T-P-C: 2- 1- 0- 3

Course Objectives

- This course helps the students to understand discrete mathematical structures and formalism.
- This course helps the students to formalize and to formulate discrete concepts and algorithms.
- This course helps the students to understand the standard hierarchy of formal grammars and their corresponding automata.
- This course helps the students to visualize symbolic computation with automata.
- This course helps the students to understand decidable and undecidable problems in computer science, and appreciate the Turing thesis.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyze formalisms and write formal proofs for properties

CO2: Use grammatical notations to represent sequence manipulation problems

CO3: Apply various formal grammars to the problem-solving avenues

CO4: Identify limitations of some computational models and possible methods of proving them

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Automata and formal language - Finite State machines – Deterministic finite state machine – Non-Deterministic finite state machine- Equivalence of NFA and DFA –Minimization of Finite State Machine – Regular Expression -Regular Language – Properties of Regular Languages.

Unit 2

Context Free Grammar -Pushdown Automata – Variants of Pushdown automata – Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Sentential Forms, Parse Tress Equivalence between PDA and CFG- Context Free Languages – Properties of CFL – Normal Forms.

Unit 3

Context Sensitive Language- Linear Bound Automata- Turing Machine – Variants of Turing Machine – Decidability- Post correspondence problem – Introduction to undecidable problems.

Textbooks/References

Peter Linz, Introduction to Formal Languages and Automata, 6Th Edn by, Jones & Bartlett, 2016.
J.E.Hopcroft, R.Motwaniand andJ.D.Ullman, , Introduction to Automata Theory, Languages and Computation', Pearson, 2001
H.R.Lewis and C.H.Papadimitriou , Elements of the Theory of Computation', , Prentice Hall, 1997/Pearson 1998

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE303	**DATABASE MANAGEMENT SYSTEMS**	**L-T-P-C: 2- 1- 3- 4**

Course Objectives

- This course aims to understand the concepts of database design, database languages, database-system implementation and maintenance.
- The course will provide knowledge of the design and development of databases for AI applications using SQL and python
- The course will provide an understanding of various databases system including modern databases systems apt for AI and ML applications

Course Outcomes

After completing this course, the students will be able to
CO1: Formulate relational algebraic expressions, SQL and PL/SQL statements to query relational databases.
CO2: Build ER models for real world databases.
CO3: Design a normalized database management system for real world databases.
CO4: Apply the principles of transaction processing and concurrency control.
CO5: Use high-level right database for AI and ML applications.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	-	-	-	-	-	-	-	-	-	1
CO2	1	3	3	3	3	-	-	-	-	-	-	-	-	-	1
CO3	2	3	2	3	-	-	-	2	2	2	2	-	-	1	2
CO4	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	-	-	-	-	-	-	-	-	1	2

Syllabus

Unit 1

Introduction: Overview of DBMS fundamentals – Overview of Relational Databases and Keys. Relational Data Model: Structure of relational databases – Database schema – Formal Relational Query Languages – Overview of Relational Algebra and Relational Operations. Database Design: Overview of the design process - The E-R

Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas - Entity Relationship Design Issues - Extended E-R Features – Alternative E-R Notations – Overview of Unified Modelling Language (UML).

Unit 2

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

Unit 3

Transactions: Transaction concept – A simple transaction model - Storage structure - Transaction atomicity and durability - Transaction isolation – Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, the two-phase locking protocol, implementation of locking, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.
Case Study: Different types of high-level databases – MongoDB, Hadoop/Hbase, Redis, IBM Cloudant, Dynamo DB, Cassandra and Couch DB etc. Tips for choosing the right database for the given problem.

Textbooks/References

Silberschatz A, Korth HF, Sudharshan S. Database System Concepts. Sixth Edition, TMH publishing company limited; 2011.
Garcia-Molina H, Ullman JD, Widom J. Database System; The complete book. Second Edition, Pearson Education India, 2011
Elmasri R, Navathe SB. Fundamentals of Database Systems. Fifth Edition, Addison Wesley

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE304	**DEEP LEARNING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course provides the basic concepts of deep learning and implementation using Matlab/Python.
- This course provides the application of deep learning algorithms in signal and image data analysis.
- This course covers the concept of deep learning algorithms such as transfer learning and attention models for signal and image analysis.

Course Outcomes (CO)

After completing this course students will be able to,

CO1: Apply the fundamentals of deep learning.

CO2: Apply deep learning algorithms using Matlab/Python.

CO3: Apply deep learning models for signal analysis.

CO4: Implement deep learning models for image analysis.

CO-PO Mapping

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

Syllabus

Unit 1

Deep Neural Networks (DNN) –Convolutional Neural Network (CNN) – Recurrent Neural Network (RNN): Long-Short- Term-Memory (LSTM) - Graph based Neural Network (GNN)

Unit 2

Pre-processing: Noise Removal using deep learning algorithms - Feature Extraction - Signal Analysis: Time Series Analysis, CNNs, Auto encoders.

Unit 3

Image Analysis: Transfer Learning, Attention models- Ensemble Methods for Signal and Image Analysis.

Text Books / Reference Books

Bishop C.M, "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2006.

Goodfellow I, Bengio Y, Courville A, & Bengio Y, "Deep learning", Cambridge: MIT Press, 1st Edition, 2016.

Soman K.P, Ramanathan. R, "Digital Signal and Image Processing – The Sparse Way", Elsevier, 1st Edition, 2012.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE305	INTRODUCTION TO CLOUD COMPUTING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course introduces the basic principles of cloud computing, cloud native application development and deployment, containerization principles, micro-services and application scaling.
- This course will also equip the students to understand major industry players in the public cloud domain for application development and deployment.

Course Outcomes

After completing this course, the students will be able to

CO1: Demonstrate the functionalities of cloud computing.

CO2: Apply cloud native application development for containerization and container orchestration.

CO3: Analyze different types of cloud services – Delivery models, Deployment models.

CO4: Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud and convert monolithic applications to containers.

CO-PO Mapping

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

Syllabus

Unit 1

Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introduction to Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development

Unit 2

Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario.

Unit 3

Virtualization – Basics, Cloud vs Virtualization, Types of virtualizations, Hypervisor types; Containers – Introduction to dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikube.

Textbooks/References

Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education;2013.

Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. " O'Reilly Media, Inc."; 2018.

Gift, Noah. Pragmatic AI: An Introduction to Cloud-based Machine Learning. Addison-Wesley Professional, 2018

Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.

Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components. Packt Publishing Ltd; 2018.

Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.

Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

19LIV390	**LIVE-IN-LAB I**	**L-T-P-C: 0-0-0-3**

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Centered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Centered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human centered approach.

CO-PO Mapping

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

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality

- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	**Marks**
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

19SSK301	**SOFT SKILLS II**	**L-T-P-C: 1-0-3-2**

Course Outcomes

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.

CO # 2 - Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.

CO # 3 - Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.

CO # 4 – Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.

CO # 5 - Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.

CO # 6 – Verbal: At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.

Syllabus

Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal hygiene, professional attire, cultural adaptability. Introductions and greetings: Rules of the handshake, earning respect, business manners. Telephone etiquette: activities during the conversation, conclude the call, to take a message. Body Language: Components, undesirable body language, desirable body language. Adapting to corporate life: Dealing with people.

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spatial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa& Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Quick Maths – Tyra.
Quicker Arithmetic – Ashish Aggarwal
Test of reasoning for competitive examinations by Thorpe.E. TMH
Non-verbal reasoning by R. S. Aggarwal, S. Chand

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova
More Games Teams Play, by Leslie Bendaly, McGraw Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources
www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER VI

22AIE311	SOFTWARE ENGINEERING (PROJECT BASED)	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course presents a broad perspective on software systems engineering, concentrating on widely used techniques for developing large-scale software systems.
- This course covers a wide spectrum of software processes from initial requirements elicitation through design and development to system evolution.

- This course also covers a wide range of software development abilities and skills from analysing a problem to implementing a solution.

Course Outcomes

After completing this course, the students will be able to

CO1: Understand the basic principles of Software Engineering.

CO2: Understand how to choose the appropriate SDLC models depending on the user requirements.

CO3: Understand the concept of Requirements Engineering.

CO4: Understand the concept of Software Design.

CO5: Understand how to apply the knowledge, techniques, and skills in the development of software and its maintenance.

CO-PO Mapping

PSO/PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2											1	1	1
CO2	3	3	2	2	2						3	3			
CO3	3	3	2		1						2		3		3
CO4	3	2	3		2						2	2	1	2	3
CO5	3	2	2		2				2	2	2	2	1	1	3

Syllabus

Unit-1

Introduction to Software Engineering: Introduction, Software Failures, Software Crisis, Classification of Software, Software characteristics, Software Engineering-A Layered Technology, Basic of Life Cycle, Software Life Cycle Models: Waterfall Model, V-Model, Prototype Model, Incremental Model, Iterative Model, Evolutionary Process Model, Spiral Model, Agile Manifesto, Principles of the agile manifesto, Various Agile methodologies: Scrum, Extreme programming.

Unit-2

Requirement Engineering: Basic concepts of Requirements Analysis and Specification, Role of a system analyst, SRS document and its important parts, properties of a good SRS document, functional requirements, non-functional requirements, decision tree, and decision table.

Design Engineering: Basic Concepts of Software Design, Preliminary and detailed design, Characteristics of a good software design, cohesion and its types, coupling and its types, function-oriented design approach, and object-oriented design approach. Data Flow Diagrams, Structured Design.

Unified Modelling Language (UML): Basic concepts of UML, Different types of diagrams, and views supported in UML.

Unit-3

User interface design: Basic concepts of user interface design, Types of User Interfaces.

Coding and Testing: Coding- Coding Standards and Guidelines, Code Review- Code Walkthrough, Code Inspection, Clean Room Testing. Testing- Basic Concepts of Testing and Terminologies, Testing Activities, Why Design Test Cases?, Testing in the Large versus Testing in the Small, Unit Testing, Black-box Testing- Black-box Test Suite Design Approach: Equivalence Class Partitioning, Boundary Value Analysis, White-Box Testing-Basic concept, statement coverage, branch coverage, Multiple Condition Coverage, Path Coverage, McCabe's Cyclomatic Complexity Metric, Data Flow-based Testing, Mutation Testing, Grey-Box Testing, Integration Testing, System Testing, Smoke Testing- Performance Testing, Error Seeding, Some General Issues Associated with Testing. Debugging techniques. Software Documentation- Internal Documentation, External Documentation.

Text Books

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

Rajib Mall, "Fundamentals of Software Engineering", Fifth Edition, PHI

Reference Books

Pankaj Jalote's, Software Engineering: A Precise Approach, *Wileyindia, 2010*

Crowder JA, Friess S. Agile project management: managing for success. Cham: Springer International Publishing; 2015.

Stellman A, Greene J. Learning agile: Understanding scrum, XP, lean, and kanban. " O'Reilly Media, Inc."; 2015.

Gregory J, Crispin L. More agile testing: learning journeys for the whole team. Addison-Wesley Professional; 2015.

Rubin KS. Essential Scrum: a practical guide to the most popular agile process. Addison-Wesley; 2012.

Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE312	BIG DATA ANALYTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- To understand how to use Big data frameworks and APIs.
- To conceptualize data analysis.
- To learn about various data processing and pipelining strategies.
- To understand and visualize map-reduce computing paradigm.
- To learn the intricate and distributed working of Big Data clusters
- To train and impart the skills required for managing and balancing large data clusters

Course Outcomes (CO)

After completing this course student will be able to,

CO1: Solve problems through map-reduce approach

CO2: Implement data analytics solutions using general data pipelining

CO3: Apply scaling up machine learning techniques and associated computing techniques and technologies.

CO4: Identify the characteristics of datasets and compare the trivial data and big data for various applications.

CO-PO Mapping

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

Syllabus

UNIT 1

Classification of Digital Data, Structured and Unstructured Data – Introduction to Big Data: Characteristics – Evolution – Definition, - Data Warehouse, Hadoop ecosystem in Brief, Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression -Terminologies used in Big Data Environments - NoSQL, Comparison of SQL and NoSQL, Distributed Computing Challenges - Hadoop Distributed File System - Processing Data with Hadoop - Basically Available Soft State Eventual Consistency, programming paradigm - Functional Programming in Scala: Basic Syntax-type inference- Parameters-Recursive arbitrary collections – ConsList-Arrays-Tail recursion- Higher order functions

UNIT 2

MapReduce Template-Pattern Matching syntax, objects in Scala. Apache Spark: -Resilient Distributed Datasets - Creating RDDs, Lineage and Fault toleranc, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization -Formatting and housing data from spark RDDs--Persistence.

UNIT 3

Data frames, datasets, Apache Spark SQL, Setting up a standalone Spark cluster-: spark-shell, basic API, Modules-Core, Key/Value pairs and other RDD features, MLlib-examples for bi-class SVM and logistic regression.

UNIT 4

MongoDB: Why Mongo DB - Terms used in RDBMS and Mongo DB - Data Types - MongoDB Query Language. Stream and Graph Processing on Spark.

Text Books / Reference Books

Learning Spark: Lightning-Fast Big Data Analysis', Holden Karau , Andy Konwinski, Patrick Wendell and MateiZaharia, O'Reilly; 1st edition , 2015

'Programming in Scala: A Comprehensive Step-by-Step Guide', Martin Odersky,Lex Spoon andBill Venners, Artima Inc; Version ed. edition , 2008

'High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark', Holden Karau, Rachel Warren, O'Reilly; 1st edition, 2017

'Scala for the Impatient', Cay S. Horstmann, Addison-Wesley; 2nd edition, 2017

"Mongo DB in Action", Kyle Banker, Manning Publications; 2nd edition, 2016

"MongoDB: The Definitive Guide", Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, O'Reilly; 3rd edition, 2019

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE313	**COMPUTER VISION AND IMAGE PROCESSING**	**L-T-P-C: 2- 1- 3- 4**

Course Objectives

- This course introduces the geometry of image formation and its use for 3D reconstruction and calibration.
- This course introduces the analysis of patterns in visual images that are used to reconstruct and understand objects and scenes.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply image formation and camera calibration for various applications.
CO2: Analyze and select image features and apply for image matching.
CO3: Develop image recognition algorithms.
CO4: Develop stereo vision applications for distance estimation.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Camera calibration. Edge Detection, Segmentation.

Unit 2

Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature-based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit 3

Recognition – object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, 3D reconstruction.

Textbooks/References

Szeliski R. Computer Vision: Algorithms and Applications Springer. New York. 2010..
Shapiro LG, Stockman GC. Computer Vision: Theory and Applications. 2001.
Forsyth DA, Ponce J. Computer Vision: a modern approach;2012.
Davies ER. Machine vision: theory, algorithms, practicalities. Elsevier; 2004 Dec 22.
Jain R, Kasturi R, Schunck BG. Machine vision. New York: McGraw-Hill; 1995 Mar 1

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE314	COMPUTER SECURITY	L-T-P-C: 2- 0- 3- 3

Course Objective

- This course provides basic knowledge and skills in the fundamental theories and practices of cyber security.
- This course provides an overview of the field of security and assurance emphasizing the need to protect information being transmitted electronically.

Course Outcomes

After completing this course, the students will be able to

CO1: Implement cryptographic techniques in secure application development

CO2: Apply methods for authentication, access control, intrusion detection and prevention

CO3: Apply fundamental security principles to analyze threat situations

CO4: Design mechanisms to provide security in a network

CO-PO Mapping

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

Syllabus

Unit 1

Basics of Computer Security: Overview – Definition of terms – Security goals – Shortcomings – Attack and defence – Malicious code – Worms – Intruders – Error detection and correction Encryption and Cryptography: Ciphers and codes – Public key algorithms – Key distribution – Digital signatures.

Unit 2

Security Services: Authentication and Key Exchange Protocols - Access control matrix – User authentication – Directory authentication service – Diffie-Hellman key exchange – Kerberos.

Unit 3

System security and Security models: Disaster recovery - Protection policies. E-mail Security: Pretty good privacy - Database Security: Integrity constraints - multi-phase commit protocols - Networks Security: Threats in networks - DS authentication -Web and Electronic Commerce: Secure socket layer - Client-side certificates - Trusted Systems: Memory protection.

Textbooks/References

William Stallings, Lawrie Brown, "Computer Security: Principles and Practice", Prentice Hall, 4th edition

Stallings William, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson/Prentice-Hall, 2018.

Forouzan B A, Cryptography and Network Security, Special Indian Edition, Tata McGraw Hill, 2007.

Padmanabhan TR, Shyamala C K, and Harini N, Cryptography and Security, First Edition, Wiley India Publications, 2011

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE315	**NATURAL LANGUAGE PROCESSING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The main objective of the course is to understand the leading trends and systems in Natural Language Processing.
- This course will help the students to understand the basic representations used in syntax, the semantics of Natural Language Processing.
- This course will help the students to understand and explore the models used for word/sentence representations for various NLP applications.
- This course will help the students to implement deep learning algorithms in Python and learn how to train deep networks for NLP applications.

Course Outcomes

After completing this course, students will be able to
CO1: Apply modern tools for solving problems in computational linguistics
CO2: Implement word representation models to solve NLP problems
CO3: Develop deep learning models for solving NLP applications
CO4: Evaluate the performance of NLP models

CO-PO Mapping

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

Syllabus

Unit 1
Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems.

Unit 2
Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Language Model-n-gram – Neural Network-based word embedding algorithms

Unit 3

Sequences and sequential data: Machine learning and deep learning for NLP, Recurrent Neural Network, Long Short-Term Memory networks, Gated Recurrent Unit - Sequence to sequence modelling - Encoder decoder - Attention mechanism, Transformer Networks – BERT, GPT, Graph NLP, Hidden Markov Model, Conditional Random Field, Topic modelling

Unit 4

Applications of NLP: Part-of-Speech tagging, Named Entity recognition, Dependency parsing, - Sentiment Analysis, Machine translation, Question answering, Text summarization, Evaluation metrics for NLP models and Visualization

Text Books / References

Daniel Jurafsky, James H Martin, Speech & language processing, preparation [cited 2020 June 1] Available from: https://web. stanford. edu/~ jurafsky/slp3 (2018).

Christopher Manning and Hinrich Schütze, F oundations of Statistical Natural Language Processing, MIT press, 1999.

Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, Inc., 2009.

Jason Browlee, Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook), Machine Learning Mastery, 2017

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

19LIV490	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

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

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	**Marks**
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation Presentation Round 1	**2**
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**

Attendance	5
Grand Total	**105**

19SSK311	SOFT SKILLS III	L-T-P-C: 1-0-3-2

Course Outcomes:

CO # 1 - Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO # 2 - Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO # 3 - Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions.

CO # 4 – Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same.

CO # 5 - Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction.

CO # 6 – Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts / ideas / opinions and share / express the same convincingly to the audience / recipient using their communication skills in English.

Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: Basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation / knowledge about the company, professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOK(S)

A Communicative Grammar of English: Geoffrey Leech and Jan Svartvik. Longman, London.
Adair. J., (1986), "Effective Team Building: How to make a winning team", London, U.K: Pan Books.
Gulati. S., (2006) "Corporate Soft Skills", New Delhi, India: Rupa& Co.
The Hard Truth about Soft Skills, by Amazone Publication.
Data Interpretation by R. S. Aggarwal, S. Chand
Logical Reasoning and Data Interpretation – Niskit K Sinkha
Puzzles – Shakuntala Devi
Puzzles – George J. Summers.

REFERENCE(S)

Books on GRE by publishers like R. S. Aggrawal, Barrons, Kaplan, The Big Book, and Nova.
More Games Teams Play, by Leslie Bendaly, McGraw-Hill Ryerson.
The BBC and British Council online resources
Owl Purdue University online teaching resources

www.the grammarbook.com - online teaching resources www.englishpage.com- online teaching resources and other useful websites.

SEMESTER VII

22AIE401	REINFORCEMENT LEARNING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course will provide a solid introduction to the field of reinforcement learning.
- It will also make the students learn about the core challenges and approaches, including exploration and exploitation.
- The course will make the students well versed in the key ideas and techniques for reinforcement learning

Course Outcomes

After completing this course, the students will be able to

CO1: Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning

CO2: Decide if an application problem should be formulated as a RL problem; if yes be able to define it formally (in terms of the state space, action space, dynamics and reward model), state what algorithm (from class) is best suited for addressing it

CO3: Implement in code common RL algorithms

CO4: Describe (list and define) multiple criteria for analysing RL algorithms and evaluate algorithms on these metrics: e.g., regret, sample complexity, computational complexity, empirical performance, convergence, etc.

CO5: Describe the exploration vs exploitation challenge and compare and contrast at least two approaches for addressing this challenge (in terms of performance, scalability, complexity of implementation, and theoretical guarantees)

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	-	-	-	3	2	3	3	3	3	3
CO 2	3	3	3	3	3	-	-	-	3	2	3	3	3	3	3
CO 3	3	3	3	3	3	-	-	-	3	2	3	3	3	3	3
CO 4	3	3	3	3	3	-	-	-	3	2	3	3	3	3	3
CO 5	3	3	3	3	3	-	-	-	3	2	3	3	3	3	3

Syllabus

Introduction to Reinforcement Learning – Elements of Reinforcement Learning – Multi-armed Bandits – Finite Markov Decision Processes – Dynamic Programming – Monte Carlo Methods – Temporal-Difference Learning – n-step Bootstrapping - Planning and Learning with Tabular Methods.

Text Books / Reference Books

'Reinforcement Learning', Richard.S.Sutton and Andrew G.Barto, Second edition, MIT Press, 2018

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

19LAW300	**INDIAN CONSTITUTION**	**L-T-P-C: P/F**

Course Objective

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

Course Outcomes

CO1: Understand the functions of the Indian government
CO2: Understand and abide the rules of the Indian constitution
CO3: Understand and appreciate different culture among the people

CO-PO Mapping

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

Syllabus

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

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

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

Text Book(s)

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

Reference(s)

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

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

22AIE498	**PROJECT PHASE - 1**	**L-T-P-C: 0- 0- 18- 6**

Course Objectives

- Project Phase – 1 aims at helping students to identify the research problems by conducting a thorough literature review
- The course introduces the students to real world problems associated with AI
- The course also aims at helping students to publish scientific articles in peer reviewed scientific publications.

Course Outcomes

After completing the course, the students will be able to

CO1: Identify a valid research problem by conducting literature review in the appropriate area.

CO2: Identify the appropriate methodology to solve the research problem.

CO3: Apply the AI tools & techniques to solve the identified problem.

CO4: Communicate scientific discoveries through peer-reviewed publications.

CO-PO Mapping

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

Evaluation Pattern

Assessment	Weightage (%)
Internal	70
External	30

SEMESTER VIII

22AIE499	PROJECT PHASE – 2	L-T-P-C: 0- 0- 30- 10

Course Objectives

- Project Phase – 2 aims at helping students to solve the identified research problem
- The course introduces the students to real world problems associated with AI
- The course also aims at helping students to publish scientific articles in peer reviewed scientific publications.

Course Outcomes

After completing the course, the students will be able to

CO1: Solve a valid research problem by employing appropriate tools & techniques.

CO2: Implement the appropriate methodology to solve the research problem.

CO3: Apply the AI tools & techniques to solve the identified problem.

CO4: Communicate scientific discoveries through peer-reviewed publications.

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	3	2	2	2	3	3	3	3	-	-	3
CO 2	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO 4	3	3	3	3	3	2	2	2	3	3	3	3	-	-	-

Evaluation Pattern

Assessment	Weightage (%)
Internal	70
External	30

PROFESSIONAL ELECTIVES

22AIE431	APPLIED CRYPTOGRAPHY	L-T-P-C: 2-0-3-3

Course Objectives

- This course will provide a strong grasp of the basic concepts underlying classical, modern cryptography and its fundamentals.
- This course will help students to understand how security is defined and proven at the cryptographic level.
- This course will help students to understand common attacks and how to prevent them.
- This course will help students to gain the ability to apply appropriate cryptographic techniques to a security engineering (and management) problem at hand.

Course Outcomes

After completing this course, students will be able to

CO1: Implement the concepts of classical and modern cryptography.
CO2: Analyze the common attacks and the preventive systems.
CO3: Apply appropriate cryptographic techniques to a security engineering problem.
CO4: Implement canonical security protocols.

CO-PO Mapping

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

Syllabus

Overview of cryptography - What is a cipher, Basic symmetric-key encryption- One time pad and stream ciphers, Block ciphers, Block cipher abstractions: PRPs and PRFs, DES and Enhancements, AES, Attacks on block ciphers, Message integrity- Message integrity: definition and applications, Collision resistant hashing, Authenticated encryption: security against active attacks, Public key cryptography- Arithmetic modulo primes, Cryptography using arithmetic modulo primes, Public key encryption, Arithmetic modulo composites, RSA, Attacks on RSA, Rabin Cryptosystem, Discrete Logarithm Problem and related Algorithms, ElGamal Cryptosystem, Introduction to Elliptic Curve Cryptography, Digital signatures: definitions and applications, More signature schemes and applications, Identification protocols, Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols.

Text Books / References

D. Bonesh and V Shoup, A Graduate Course in Applied Cryptography, Stanford university Press, Volume-0.4.

Katz, Jonathan, and Yehuda Lindell. Introduction to modern cryptography. Chapman and Hall/CRC, 2014.

Katz, Jonathan, Alfred J. Menezes, Paul C. Van Oorschot, and Scott A. Vanstone. Handbook of applied cryptography. CRC press, 1996.
Stallings, William. Cryptography and network security: principles and practice. Upper Saddle River: Pearson, 2017.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE432	**NETWORK & WIRELESS SECURITY**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course covers security and privacy issues in wireless networks and systems, such as cellular networks, wireless LANs, wireless PANs, mobile ad hoc networks, vehicular networks, satellite networks, wireless mesh networks, sensor networks and RFID systems.
- This course will lay down the Functions, protocols and configurations for realizing authentication, key distribution, integrity, confidentiality and anonymity in wireless access networks for mobile users.
- This course presents security techniques employed in existing systems, such as WPAN, WLAN, UMTS and IMS.
- This course will help students to propose solutions for new network technology, such as various types of ad-hoc networks. Digital forensics in wireless systems.

Course Outcomes

After completing this course, students will be able to
CO1: Analyze security technology and methods for communication systems that provide services for mobile users by wireless access networks.
CO2: Analyze security mechanisms and protocols in wireless communication systems, such as the topical technologies of WLAN IEEE 802.11, WAN 802.16, GSM/UMTS/LTE, Ad-hoc and sensor networks.
CO3: Apply design principles, mechanisms and solutions used in wireless network security to obtain authentication and key transport protocols
CO4: Implement the security mechanisms and protocols using canonical models.

CO-PO Mapping

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

CO4	3	2	3	3	2	3	-	-	3	3	-	3	2	2	-

Syllabus

Introduction to network security and wireless network, Wireless network technologies and application, Security and Cryptography, Network Security Protocols, Security and Layered Architecture, Voice-Oriented Wireless Networks, Data-Oriented Wireless Networks, Security in Traditional Wireless Networks, Security in Wireless LAN, Security in Wireless Ad Hoc Network.

Text Books / References

Xiao, Yang, Hui Chen, Shuhui Yang, Yi-Bing Lin, and Ding-Zhu Du. "Wireless network security." (2009), Springer.

Vacca, J. R, Guide to wireless network security. Springer Science & Business Media ,2006.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30s

22AIE433 INTRUSION DETECTION & PREVENTION SYSTEMS L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course helps the students to understand when, where, how, and why to apply Intrusion Detection tools and techniques in order to improve the security posture of an enterprise.
- This course helps the students to apply knowledge of the fundamentals and history of Intrusion Detection in order to avoid common pitfalls in the creation and evaluation of new Intrusion Detection Systems.
- This course helps the students to analyse intrusion detection alerts and logs to distinguish attack types from false alarms.

Course Outcomes

After completing this course, students will be able to
CO1: Analyze basic issues, concepts, principles, and techniques in intrusion detection.
CO2: Analyse intrusion detection systems for particular security requirements.
CO3: Design preventive systems for various engineering applications
CO4: Implement preventive systems for various engineering applications.

CO-PO Mapping

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

Syllabus

Introduction-Understanding Intrusion Detection – Intrusion detection and prevention basics – IDS and IPS analysis schemes, Attacks, Detection approaches –Misuse detection – anomaly detection – specification based detection – hybrid detection , Theoretical foundations of detection-Taxonomy of anomaly detection system – fuzzy logic – Bayes theory – Artificial Neural networks – Support vector machine – Evolutionary computation – Association rules – Clustering, Architecture and implementation-Centralized – Distributed – Cooperative Intrusion Detection – Tiered architecture, Justifying intrusion detection-Intrusion detection in security – Threat Briefing –Quantifying risk – Return on Investment (ROI), Applications and tools -Tool Selection and Acquisition Process – Introduction to various commonly used IDS and IPS Systems - Bro Intrusion Detection – Prelude Intrusion Detection – Cisco Security IDS – Snorts Intrusion Detection – NFR security, Legal issues and Organizations standards-Law Enforcement / Criminal Prosecutions – Standard of Due Care – Evidentiary Issues, Organizations and Standardizations.

Text Books / References

Ali A. Ghorbani, Wei Lu, "Network Intrusion Detection and Prevention: Concepts and Techniques", Springer, 2010.
Carl Enrolf, Eugene Schultz, Jim Mellander, "Intrusion detection and Prevention", McGraw Hill, 2004 Paul E. Proctor, "The Practical Intrusion Detection Handbook ", Prentice Hall, 2001.
Ankit Fadia and Mnu Zacharia, "Intrusiion Alert", Vikas Publishing house Pvt., Ltd, 2007.
Earl Carter, Jonathan Hogue, "Intrusion Prevention Fundamentals", Pearson Education, 2006.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE434 SOFTWARE VULNERABILITY ANALYSIS L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course teaches software engineering techniques for building security into software as it is developed.
- This course introduces students to the discipline of designing, developing, and testing secure and dependable software-based systems.

- This course provides hands on experience in software security analysis and development using Fortify, Threat Modelling, and Rational AppScan software.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse the security risk of a system under development.
CO2: Apply secure coding practices to prevent common vulnerabilities from being injected into software.
CO3: Design security requirements (which include privacy requirements).
CO4: Validate security requirements.

CO-PO Mapping

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

Syllabus

Introduction to software and system security principles-Confidentiality, Integrity, and Availability, Isolation, Least Privilege, Compartmentalization, Threat Model, Bug versus Vulnerability, Secure Software Life Cycle-Software Design, Software Implementation, Software Testing, Continuous Updates and Patches, Modern Software Engineering, Memory and Type Safety - Pointer Capabilities, Memory Safety, Spatial Memory Safety, Temporal Memory Safety, a Definition of Memory Safety, Practical Memory Safety, Type Safety, Défense Strategies – Software verification, Software testing, Language-based security, Mitigations – data execution prevention, Address space layout randomization, Stack integrity, Safe exception handling, Fortify source, Control flow integrity, Code pointer integrity, sandboxing and software-based fault isolation, Attack vectors – Denial of service, information Leakage, Privilege escalation, Web security- Browser security, Command injection, Sql injection , Cross site scripting, Mobile security- Android system security, application-specific security measures.

Text Books / References

Mathias Payer, "Software Security: Principles, Policies, and Protection", HexHive Books, edition 0.35, 2019
Anderson, Ross. Security engineering. John Wiley & Sons, 2008.
Dowd, Mark, John McDonald, and Justin Schuh. The art of software security assessment: Identifying and preventing software vulnerabilities. Pearson Education, 2006.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE435 CYBERCRIME INVESTIGATIONS & DIGITAL FORENSICS L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course provides an overview of global reach of the Internet and various cybercrimes in various domains.
- This course provides an overview of cybercrime and the digital law enforcement practices put in place to respond to them.
- The course will focus on the types and extent of current cyber-crimes, how the justice system responds to these crimes, the various constitutional protections afforded to computer users, the law and policies that govern cybercrime detection and prosecution, and related technologies.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse the nature and scope of cybercrime.
CO2: Develop knowledge of major incidents of cybercrime and their resulting impact.
CO3: Analyse national and global digital law enforcement efforts
CO4: Evaluate the specific technology that facilitates cybercrime and digital law enforcement

CO-PO Mapping

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

Syllabus

Introduction to cybercrime, criminal law, courts, and law-making, Types of computer-related crimes, Sources of cybercrime law (substantive and procedural), Technology, cybercrime, and police investigations, Technology and crime, Cyber deviance, cybercrime, and cyber terror, Computer misuse crimes, Malware and automated computer attacks, Malware, DDoS attacks, and Botnets, Digital piracy and Intellectual property theft, Digital piracy, Copyright, trademark, and trade secrets, Pornography, prostitution, and sex crime, The Fourth Amendment, computers, and computer networks, Digital/Computer Forensics -Introduction to digital and computer forensics, Legal issues related to digital investigations, National security.

Text Books / References

Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar. 2015. Cybercrime and Digital Forensics: An Introduction. New York: Routledge. ISBN: 978-1138021303.
Nate Anderson. 2014. The Internet Police: How Crime Went Online, and the Cops Followed. New York: W.W. Norton & Company, Inc. ISBN: 978-0393349450.
Peter Grabosky. 2016. Cybercrime. Oxford/New York: Oxford University Press. ISBN: 978-0190211554. Kevin F. Steinmetz. 2016. Hacked: A Radical Approach to Hacker Culture and Crime. New York: New York University Press. ISBN: 978-1479869718.
Orin S. Kerr. 2013. Computer Crime Law (3ded.). St. Paul: Thomsen Reuters. ISBN: 978-0314281364. Susan W. Brenner. 2012. Cybercrime and the Law: Challenges, Issues, and Outcomes. Lebanon, NH: Northeastern University Press. ISBN: 978-1555537999.
Ralph D. Clifford. 2011. Cybercrime: The Investigation, Prosecution and Defense of a Computer-related Crime. Durham: Carolina Academic Press. ISBN: 978-1594608537.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE436	DISTRIBUTED SYSTEM SECURITY	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course emphasises on the techniques for creating functional, usable, and high-performance distributed systems.
- The course focuses on security in networks and distributed systems, and gives a short introduction to cryptography.
- The course covers threats against distributed systems, as well as applicable methods, technologies and standards to protect against these threats.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse threats against distributed systems and the protection measures against such threats
CO2: Design secure distributed systems to evaluate the security of existing solutions.
CO3: Analyse the principles and standards of security protocols.
CO4: Implement cryptographic mechanisms to secure modern distributed systems.

CO-PO Mapping

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

Syllabus

Understanding the Core Concepts of Distributed Systems -distributed systems designs, system constraints, trade-offs and techniques in distributed systems, distributed system for different data and applications, Distributed system security-Access and location transparency, Processes and Communication, naming, Parallelization of tasks - Concurrency and Synchronization, Consistency and Replication, Distributed system Security and network protocols – types of attacks, encryption algorithms, authentication, public key cryptosystems, data verification.

Text Books / References

Andrew S. Tannenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Pearson, 2007.

Belapurkar, Abhijit, Anirban Chakrabarti, HarigopalPonnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, and Srikanth Sundarrajan. Distributed systems security: issues, processes and solutions. John Wiley & Sons, 2009.

George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition, Addison Wesley, 2011.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE437	**MEDICAL IMAGE PROCESSING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives:

- To provide the basics of different medical image modalities.
- To introduce the basic concepts applied in medical image processing.
- To introduce different machine learning/deep learning-based algorithms for medical image analysis.
- To apply tools and methodologies for medical image processing and analysis.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply basic image processing techniques in medical data.

CO2: Implement image enhancement algorithms in medical data.

CO3: Implement image segmentation algorithms in medical data.

CO4: Apply machine learning/deep learning algorithms for medical image analysis.

CO-PO Mapping

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

CO2	3	2	2	2	3	3	-	-	3	3	2	3	3	3	2
CO3	3	2	2	2	3	3	-	-	3	3	2	3	3	3	2
CO4	3	3	2	2	3	3	-	-	3	3	2	3	3	3	3

Syllabus:

Unit 1

Imaging Modalities: Survey of major modalities for medical imaging: Ultrasound, X-ray, CT, MRI, PET, and SPECT.

Unit 2

Image Processing and Analysis: Registration, Feature Extraction: Edge Detection, Hough transform, Filtering: Noise removal and Image Enhancement, Segmentation, Domain transformation.

Unit 3

Introduction to Machine Learning/Deep Learning Approaches for Biomedical Image Classification, Biomedical Image Segmentation, Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images.

Textbooks/ References:

Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts and Applications", Prentice Hall, 2014.

Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007.

Rangayyan R M, "Biomedical Image Analysis", Fifth Edition, CRC Press, 2005.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE438	BIOMEDICAL SIGNAL PROCESSING	L-T-P-C: 2- 0- 3- 3

Course Objectives

The objectives of this course are:

- To provide the basics of different types of biomedical signals.
- To introduce the basic concepts of time domain and frequency domain analysis in biomedical signals.
- To introduce machine learning/deep learning-based algorithms for biomedical signal analysis.
- To impart skills to develop efficient deep learning models on biomedical data.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply basic time domain processing techniques in biomedical signals.

CO2: Implement frequency domain transformation algorithms in biomedical signals.

CO3: Implement decomposition-based filtering techniques in biomedical signals.

CO4: Apply machine learning/deep learning algorithms for biomedical signal analysis.

CO-PO Mapping

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

Syllabus:

Unit 1

Introduction to Biomedical Signals: Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Unit 2

Biosignal Analysis: Time-domain analysis of Biosignals, Fourier Spectrum of Biosignals, Short Time Fourier Transform and Spectrogram, Discrete Cosine Transform and its Applications, Signal Decomposition based filtering: Wavelet Transform, Hilbert Transform, Empirical Mode Decomposition and Empirical Wavelet Transform.

Unit 3

Introduction to Machine Learning/Deep Learning Approaches for Biomedical Signal Detection and Classification. Performance Measures for Detection and Classification System. Case studies on some recent advances in analysis of biomedical signals.

Textbooks/ References:

Rangayyan R M, "Biomedical Signal Analysis: A case-study approach", Wiley India, 2009.

Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", Wiley Inter-Science, 1st edition, 2000.

John.L.Semmlow, "Biosignal and Biomedical Image Processing: Matlab-based applications", CRC, 1st edition, 2004.

Stephen Mallet, "A Wavelet Tour of Signal Processing: The Sparse Way", 3rd edition, Academic Press, 2008.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE439	**CLINICAL INFORMATION SYSTEM**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- To gain insights and situational experience with clinical information systems.
- To examine the effective use of data and information technology to assist the students to easily migrate from paper-based systems to CIS, thereby improving organizational performance.
- To understand the impacts of CIS on patients and health care providers.

Course Outcomes

After completing this course, students will be able to:

CO1: Explore the basics of clinical information systems.

CO2: Apply information technology and related tools in workflow design.

CO3: Explore the "benefits and barriers" associated with electronic health records.

CO4: Apply strategies for minimizing the major barriers to the adoption of electronic health records.

CO-PO Mapping

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

Syllabus:

Unit 1

Introduction to clinical information systems – contemporary issues in healthcare – workflow and related tools for workflow design – electronic health records databases – Healthcare IT & portable technology.

Unit 2

Data mining in health care, Artificial intelligence in health care: Use of AI, The healthcare industry, Electronic medical records, Clinical decision support systems.

Unit 3

Bioethics and challenges to deployment, Challenges in clinical decision support.

Textbooks/ References:

Sittig & Ash, Clinical Information Systems – Overcoming Adverse Consequences, Jones & Bartlett Learning Publishers, 2009.

Edward H. Shortliffe; Leslie E. Perreault, Medical Informatics – Computer Applications in Healthcare and Biomedicine, Springer-Verlag New York Inc. Publishers, 2014.

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20

Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE440 KINEMATICS & KINETICS FOR ROBOTICS L-T-P-C: 2-0-3-3

Course Objectives

- To introduce the basic concepts of Kinetics & Kinematics of robotic systems and investigate the connections between Kinetics and Kinematics of robotic systems.
- The course will introduce the state-of-the-art computational tools to solve the Kinetics and Kinematics problems

Course Outcome

After completing this course, the students will be able to

CO1: Understand the fundamentals of Kinematics & Kinetics for Robotics.

CO2: Apply the concepts of vector mechanics for solving Kinematics problems.

CO3: Apply computational techniques to solve Kinematics & Kinetics problems.

CO4: Implement computational models for Kinematics & Kinetics problems.

CO-PO Mapping

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

Syllabus

Components and Mechanisms of a Robotic System – Link – Joint – Manipulator – Actuator – Sensor – Controller – Kinetics and Kinematics of Robots – Rotation Kinematics – Rotation about Global and Local Axes – Euler angles – Transformation Matrices – Rotation Matrix – Quaternion – Composition and decomposition of Rotations - Homogeneous transformation – Inverse Homogeneous transformation – Compound homogeneous transformation – Forward Kinematics – D-H Notation – Inverse Kinematics – Angular Velocity – Velocity Kinematics – Numerical Methods in Kinematics.

Textbooks/References

Theory of Applied Robotics: Kinematics, Dynamics & Control – R. Jazar, Springer, 2010.

Statics and Kinematics with application to Robotics: J. Duffy, Cambridge University Press, 1996.

Kinematics and Dynamics of Machinery – Wilson & Sadler, Third Edition, Pearson Publication, 2003.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE441	**DYNAMICS & CONTROL OF ROBOTICS**	**L-T-P-C: 2-0-3-3**

Course Objectives

- To provide a mathematical foundation to dynamics and control of robotic systems and introduce a set of analytical and computational tools for the modelling and control of robots.
- This will enable the students to simulate and control robotic motion for various types of robotic systems.

Course Outcome

After completing this course, the students will be able to

CO1: Develop mathematical models for dynamics and control of robotic systems.

CO2: Apply analytical and computational tools for modelling and control of robots.

CO3: Simulate simple robotic motion.

CO4: Control simple robotic motion.

CO-PO Mapping

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

Syllabus

Dynamics of Robotics – Acceleration Kinematics – Motion Dynamics – Review of Rigid body Kinetics – Translational Kinetics – Rotational Kinetics – Rigid link acceleration – Newton-Euler dynamics – Recursive Newton – Euler Dynamics – Lagrange Equations – Robot Statics – Introduction to control of robotics – Path Planning – Polynomial Path – Non-Polynomial Path – Cartesian Path – Rotational Path – Manipulator Motion – Time optimal control – Bang – Bang control – Open Loop and Closed Control – Classical Control Techniques – Modern Control Techniques – Sensing and Control.

Textbooks / References

Theory of Applied Robotics: Kinematics, Dynamics & Control – R. Jazar, Springer, 2010.

Advances in Robotics, automation and control: Aramburo& Trevino, In-Tech Publishers, 2008.

Robotics: Modelling, Planning & Control- B Siciliano, L Sciavicco, L Villani & G Oriolo. Springer Text books in Control and Signal Processing, 2009.

Aspects of Soft Computing, Intelligent Robotics and Control –Janos Fodor – Springer Publishers, 2009.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE442 ROBOTIC OPERATING SYSTEMS & ROBOT SIMULATION L-T-P-C: 2- 0- 3- 3

Course Objectives

- To provide an introductory understanding on robotic operating system and gazebo simulation environment.
- To introduce the students with module developments in ROS for mobile robot control, navigation and environment mapping.
- To introduce the students with module developments in ROS for industrial robot control, path planning and trajectory planning.

Course Outcomes

After completing this course student will be able to,

CO1: Apply the principles of ROS for module development of robotic systems.

CO2: Analyse various robotic systems using ROS integrated simulation platforms.

CO3: Apply the knowledge of robotic system and ROS for mobile robot control, navigation and environment mapping using ROS simulators.

CO4: Develop prototypical robotic systems using ROS for real-time problems.

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PS O2	PS O3
CO															
CO1	1	2	1	1	3	2	-	-	3	3	-	2	2	3	2
CO2	3	2	1	2	3	2	-	-	3	3	-	-	2	3	2
CO3	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2

CO4	3	2	3	2	3	-	3	3	3	3	3	2	2	3	2

Syllabus

ROS concepts - Preliminaries – Publishing a topic – Subscribing to a topic – Latched topics – Defining message types – Mixing Publishers and subscribers – Services – Defining a service – Implementing a service – Using a service – Actions – Definition of an Action – Implementing a basic action server – Robots model and Simulators – Sub systems – Actuation: Mobile platform – Actuation manipulator arm – Cameras and Scanners

Text Book /Reference Books

Joseph, Lentin, and Jonathan Cacace. Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. Packt Publishing Ltd, 2018.

Programing Robots with ROS', M. Quigley, B. Gerkey, and W. D. Smart, Oreilly Publishers, 2015.

Koubâa, Anis, ed. Robot Operating System (ROS). Vol. 1. Cham: Springer, 2017.

'ROS Robotics by example', Fairchild & Harman, PACKT Publishing, 2016

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE443	**Underactuated Robotics**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course covers nonlinear dynamical aspects and control of mechanical systems that are underactuated, with a focus on computational approaches.
- The course helps in establishing the understanding of nonlinear dynamics of robotic manipulators, applied optimal and robust control and motion planning
- The course aims to discuss examples from biology and applications to legged locomotion, compliant manipulation, underwater robots, and flying machines.

Course Outcomes

After completing this course, students will be able to:

CO1: Analyze nonlinear underactuated systems

CO2: Demonstrate simple robot models for walking and running

CO3: Simulate the dynamics and control of Highly articulated robots

CO4: Perform nonlinear planning and control of simple robot models.

CO-PO Mapping

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

Syllabus

Underactuated systems – Introduction, Nonlinear modeling – Simple pendulum, Nonlinear analysis of complicated systems – Acrobots - Cart-poles – Quadrotores – Pendubot - Inertia wheel pendulum - Furuta pendulum (horizontal rotation and vertical pendulum) – Hovercraft, Models for – Walking – Running – Walking and Running, Highly-articulated Legged Robots, Model Systems with Stochasticity, Nonlinear Planning and Control – Dynamic programming, Linear Quadratic Regulators, Lyapunov Analysis, Trajectory Optimization, Policy Search, Motion Planning as Search, Feedback Motion Planning, Robust and Stochastic Control, Output Feedback, Algorithms for Limit Cycles, Planning and Control through Contact, Estimation and Learning - System Identification, State Estimation, Model-Free Policy Search

Textbooks:

Anthony Bloch and P. Crouch and J. Baillieul and J. Marsden, "Nonholonomic Mechanics and Control", Springer, April 8, 2003.
Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Boulder, CO: Westview Press, 2001. ISBN: 9780738204536.
Fantoni, Isabelle, and Rogelio Lozano. Non-linear Control for Underactuated Mechanical Systems. New York, NY: Springer-Verlag, 2002. ISBN: 9781852334239.
Bertsekas, Dimitri P. Dynamic Programming and Optimal Control. 3rd ed. Vols. I and II. Nashua, NH: Athena Scientific, 2007. ISBN: 9781886529083 (set).
LaValle, Steven M. Planning Algorithms. New York, NY: Cambridge University Press, 2006. ISBN: 9780521862059.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE444	PROBABILISTIC ROBOTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims at statistical techniques for representing information and making decisions in robotics.
- The course helps to overcome the uncertainty that arises in most contemporary robotics applications.

Course Outcomes

After completing this course, students will be able to:

CO1: Enumerate the fundamental aspects concerning mobile robotics.

CO2: Apply state estimation techniques and observability filters to mobile robots.

CO3: Apply simultaneous localization and mapping and its variations for mobile robot path planning.

CO4: Analyze the decision-making process for mobile robots.

CO-PO Mapping

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

Syllabus

Introduction & Robot Paradigms, State Estimation, Gaussian Filters - Kalman Filter - Extended Kalman Filters & Geometric Approach, Nonparametric Filters - Discrete and Particle Filters, Wheeled Locomotion & Robot Motion Models, Sensors & Robot Perception Models, Mapping with known poses, SLAM - The FastSLAM Algorithm - GraphSLAM - Self SLAM, Exploration and 3D Mapping, Uncertain knowledge and reasoning - Probabilistic Reasoning - Probabilistic Reasoning over Time - Making Simple Decisions - Making Complex Decisions -Multiagent Decision Making – Robotics.

Text Books / Reference Books

Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, The MIT Press, 2005. ISBN: 9780262201629, 3rd edition.
Stuart Russell and Peter Norvig 'Artificial Intelligence - A Modern Approach' 3rd edition.
Machine Learning: A Probabilistic Perspective, Kevin Patrick Murphy. MIT Press, 2012.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)

Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE445	**SENSORS AND ACTUATORS FOR ROBOTICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course aims to give a reasonable understanding of the principles and operations of sensors and actuators for robotics
- The course helps with the selection of sensors and actuators for the robot based on the application.

Course Outcomes

After completing this course, students will be able to:

CO1: Distinguish the different classes of sensors and actuators suitable for robotics application

CO2: Analyze the principle of operation of different sensors and actuators used in robotics application

CO3: Design sensors and actuators for robotics applications with easy implementation and cost-effectiveness.

CO4: Identify the best sensor and actuator for accomplishing the work with accuracy, convenient operating features, and great functionality.

CO-PO Mapping

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

Syllabus

Sensors for robots: Sensor classification and characteristics, Touch and proximity sensors: IR, Photodiodes. Tactile sensors, collision sensors, interaction sensors – proximity/distance sensors, Position measurement: Optical encoder, Potentiometer, 2D and 3D cameras, Velocity measurement. Inertial sensors: Gyroscopes, Accelerometer. Force sensors, Torque sensors. Range sensors: IR, Ultrasonic sensors, laser ranger finder. Robot actuators: Hydraulic actuators, Pneumatic Actuator, Electrical actuator, Introduction to motors: DC motors, AC motors, Stepping motors, Servo motors. Motion transmission: Gear transmission, Belt transmission. Harmonic drive.

Text Books / References

Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction, 2nd edition. Nathan Ida, 2020.

Industrial Robotics: Technology Programming and Applications, 2nd Edn, Mikell P Groover, Tata McGraw Hill Education Private Limited, 2012.
John J Craig, Introduction to Robotics, Mechanics and control, second edition Addison – Wesley, 1999.
Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Prentice Hall of India, 1996.
http://www.societyofrobots.com/robot_tutorial.sh tml#sensors
http://www.sensorcentral.com/photoelectric/ultra sonic01.php

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE446	**NLP FOR ROBOTICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course aims to introduce spoken language technology with an emphasis on dialog and conversational systems
- The course helps in establishing the understanding of Deep learning and other methods for automatic speech recognition, speech synthesis systems for robotics

Course Outcomes

After completing this course, students will be able to:

CO1: Apply the basics of speech and language processing for robotics.

CO2: Build Dialog systems using the NLP pipeline for robotics.

CO3: Implement different end-to-end deep neural network approaches for speech recognition.

CO4: Build text to speech systems for dialogue systems

CO-PO Mapping

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

Syllabus

Introduction and Acoustic Phonetics, Overview of dialog: Human conversation. Task-oriented dialog. Dialog systems, Machine Learning in Dialog- Recurrent NNs, Attention, Transformers, Automatic Speech Recognition, Foundation models for spoken language-Using the Speech Brain ASR toolkit, Advanced ASR, Text to Speech (TTS): Overview. Text normalization, Spectrogram prediction, Vocoding, TTS Evaluation.

Text Books / Reference Books

Dan Jurafsky and James H. Martin. Speech and Language Processing, (3rd ed. draft), available at https://web.stanford.edu/~jurafsky/slp3/
Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing. Available at https://u.cs.biu.ac.il/~yogo/nnlp.pdf
Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press. Available at https://www.deeplearningbook.org/

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE447	DATA DRIVEN CONTROL IN ROBOTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

1. The course aims to review the basic modelling and control aspects of robotic systems.
2. The course then directs to data-based methods for better control of robotic systems.
3. The course also covers the computer vision part essential for data-based control of robotics.
4. The course also imparts knowledge about learning based control systems.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply principles of computer vision and machine learning for robotic control

CO2: Model dynamical robot systems using data driven techniques.

CO3: Apply machine learning techniques to build more robust robotic systems

CO4: Apply neural networks to do overall control of mobile robots.

CO-PO Mapping

PO															

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	3	-	-	-	3	3	-	3	2	2	3
CO 2	3	3	3	3	3	-	2	1	3	3	-	3	-	2	3
CO 3	3	3	3	3	3	2	2	1	3	3	-	3	-	2	3
CO 4	3	3	3	3	3	2	2	1	3	3	-	3	-	2	3

Syllabus

System Modeling - Control System Principles - Computing, Measurement, State, and Parameter Estimation - Decision-Making and Machine Learning - Numerical Methods for Evaluation and Search - Expert Systems - Neural Networks for Classification and Control - Vision for Robots: Mid-Level Visual State Estimation, Direct Perception, Active and Interactive Perception, Self-Supervised Image Representations: Unstructured Full-Scene Representations, Object and Key point - Structured Representations. Learning - Based Control: Predictive Models and Forward Dynamics Models, Model-Based Reinforcement Learning and Visual Servoing, Model-Free Reinforcement Learning and Sim-to-Real Transfer, Learning from Demonstrations.

Text Books / Reference Books

H. Asada and J.-J. Slotine, Robot Analysis and Control, J. Wiley & Sons, 1986.
M. Brady, J. Hollerbach, T. Johnson, T. Lozano-Perez, and M. Mason, Robot Motion: Planning and Control, MIT Press, 1984.
P. Corke, Robotics, Vision, and Control, Springer, 2011.
A. Staugaard, Jr., Robotics and AI: An Introduction to Applied Machine Intelligence, Prentice-Hall, 1987.
P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.
D. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.
D. Kortenkamp, R. Bonasso, and R. Murphy, ed., Artificial Intelligence and Mobile Robots, AAAI Press, 1998.
K. P. Valavanis and G. N. Saridis, Intelligent Robotic Systems: Theory, Design, and Applications, Kluwer, 1992.
P. Winston and R. Brown, Artificial Intelligence: An MIT Perspective, MIT Press, 1979.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE448	INTRODUCTION TO DRONES	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The main aim of this course is to understand the basics of Unmanned Arial Vehicles (Drones) and its various applications in the age of artificial intelligence.
- The course will take the students to understand the basic dynamics of drone based flying system.
- The course will provide the knowledge of basic electronic components and their working principles in a drone/ Unmanned Aerial vehicle system
- The course will also impart the knowledge of how to fly a drone by considering the rules and regulations to the specific country.

After completing this course, the students will be able to

CO1: Distinguish the right drone / UAV flying regulations specific to India

CO2: Analyse the working principles of various electronic components to build the drone

CO3: Apply the concept of drone dynamics and different movements during flight

CO4: Illustrate UAV flying in the given environment

CO-PO Mapping

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

Syllabus

Introductions to drones and its applications in the age of AI, Drone regulations specific to India, Basics of drone dynamics for flying - frame types, propellers, types of drones, dynamics specific to quadcopter, Understanding UAV movements (Quadcopter), How to fly a drone, Introduction to drone electronic components, working principle behind each electronic component, Drone and electronic assembly, flying experiments.

Textbook / References

Syed Omar Faruk Towaha, Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266, Packt Publishing, 2018.

Barnhart, R. Kurt, Douglas M. Marshall, and Eric Shappee, eds. Introduction to unmanned aircraft systems. Crc Press, 2021.

Garg, P. K. Unmanned Aerial Vehicles: An Introduction. Stylus Publishing, LLC, 2021

Kimon P. Valavanis, Handbook of Unmanned Aerial Vehicles, Volume4, Springer Netherlands, 2014.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE449 INTRODUCTION TO DIGITAL MANUFACTURING L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course will at imparting the knowledge of basics of digital manufacturing and its importance in current era.
- It will also equip the students to understand about the basics of Additive manufacturing used in various industry applications.
- Further it will expose the students to additive manufacturing technology using 3-D printing.

Course Outcomes

After completing this course, the students will be able to

CO1: Assemble and use a 3D printer.

CO2: Design simple 3D design using CAD packages.

CO3: Illustrate Slicing and evaluate the model in a CAD packages.

CO4: Design small robots and DIY projects comprising of 3D printed parts.

CO-PO Mapping

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

Syllabus

History of Manufacturing: From classical to Additive manufacturing, 3D Printers and Printable Materials, 3D Printer Workflow and Software, selecting a printer: Comparing Technologies, working with a 3D Printer, 3D Models, Applications, Building Projects

Textbook/References:

Joan Horvath, Rich Cameron, Mastering 3D Printing in the Classroom, Library and Lab, Apress, 2018.

https://ultimaker.com/en/resources/education/3d-printing-in-the-classroom

Brian Evans, Practical 3d Printers the Science and Art of 3d Printing, Apress, 2018.

Chris Anderson, Makers-The New Industrial Revolution, Crown Publishing, 2018.

Kalani Kirk Hausman and Richard Horne 3D Printing for Dummies, Wiley Publications, 2018.

Ben Redwood, Filemon Schoffer, Brian Garret, 3D Printing Handbook, Technologies design and Applications, 3D Hubs, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE450	**SPEECH PROCESSING**	**L-T-P-C: 2- 0- 3- 3**

Course Objective

- The objective of the course is to understand acoustic theory behind the human speech production systems.
- As a part of this course students will be able to analyze time and frequency domain features from a speech signal.
- Further student will be able to implement ML/DL based models for speech technology applications.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse the acoustics behind of the production of a speech signal

CO2: Differentiate the characteristics of different speech sounds

CO3: Analyse the time-domain and frequency domain features of the speech signal

CO4: Implement various ML/DL approaches for modelling speech towards applications such as classification, detection, and recognition

CO-PO Mapping

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

CO															
CO1	2	2	-	2	2	---	---	---	1	2	1	2	1	1	-
CO2	2	2	-	2	2	---	---	----	3	2	2	2	2	2	1
CO3	2	2	1	2	3	---	---	---	3	2	2	2	2	2	2
CO4	3	3	2	3	3	--	---	---	3	3	3	3	3	3	3

Syllabus

Overview of Speech Processing Systems, Speech Production and Perception, Speech Signal Characteristics, Properties of speech sounds-Vowels and Consonants. Short time processing of speech- Time Domain parameters, Frequency domain parameters, Spectrograms, Cepstral Analysis, Mel-frequency Cepstral Coefficients, Linear Prediction Analysis - Speech Recognition- GMM-HMM, Machine learning and Deep neural network models used for speech modelling and classification, Speech synthesis, End-to-End Models for speech technology applications.

Textbooks / References

'Fundamentals of Speech Recognition', L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, Pearson Education Inc.2009

'Speech Communication', Douglas O'Shaughnessy, University Press, 2001

'Discrete Time Speech Signal Processing', Thomas F Quatieri, Pearson Education Inc., 2004

Hannun, Awni, et al. "Deep speech: Scaling up end-to-end speech recognition." arXiv preprint arXiv:1412.5567 (2014).

Collobert, Ronan, Christian Puhrsch, and Gabriel Synnaeve. "Wav2letter: an end-to-end convnet-based speech recognition system." arXiv preprint arXiv:1609.03193 (2016).

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE451	**MODERN AND SMART MATERIALS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course aims introduce current trends in materials for innovative solutions.
- The course helps in establishing the properties of modern and smart materials involved in innovative technologies.
- The course will augment the knowledge of Computational material science by considering the modelling and simulation of modern and smart materials.

Course Outcomes

After completing this course, students will be able to:

CO1: Identify modern and smart materials for innovative solutions.

CO2: Distinguish important properties of modern and smart materials.

CO3: Simulate modern and smart materials using various approaches in computational material science.

CO4: Analyse the simulated modern and smart materials.

CO-PO Mapping

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

Syllabus

Introduction to Smart materials, Piezoelectric materials, Magenetostrictive materials, Electroactive Polymers, Chromogenic materials, Shape Memory Alloys, Heat Energy Storage materials, Electo and Magneto Rheological Fluids, Smart hydrogels and Smart Polymers. Smart materials for 4D printing. Modelling and Simulation of Smart Materials. Introduction to Nanomaterials, Nanomaterial structure, Energy at Nanoscale, Functional Nanomaterials: metal nanoparticles, quantum dots, nanoclusters, carbon-based nanomaterials, organic, inorganic, hybrid nanomaterials, biomimetic nanomaterials, Modelling and simulation of Nanomaterials – Atomistic and Quantum methods.

Text Books / Reference Books

'Engineering Analysis of Smart Material Systems', D.J. Leo, Wiley 2007.

'Smart Structures Physical Behaviour, mathematical Modelling and Applications' Paolo Gaudenzi, Wilet, 2009.

'Nanoscale Materials in Chemistry', Kenneth J. Klabunde, Ryan M. Richards, Wiley, 2009.

'Nano: The Essentials", T. Pradeep, McGraw-Hill (India) Pvt Limited, 2008.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)

Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE452 DATA DRIVEN MATERIAL MODELLING AND SIMULATION L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims to review the artificial intelligence concepts relevant to computational material science.
- The course focuses on using data driven modelling in order to solve various problems in computational material science.
- The course aims to apply the combination of artificial intelligence and material modelling to solve real systems through data-based simulations.
- The course also helps student analyse the data driven simulations and arrive at appropriate conclusions.

Course Outcomes

After completing this course, students will be able to:

CO1: Distinguish the artificial intelligence concepts applied to material science.

CO2: Apply various algorithms pertaining to machine learning to solve real-world material science problems.

CO3: Apply various algorithms pertaining to neural networks to solve real-world material science problems.

CO4: Analyse the data driven models to arrive at solutions to real-world problems in material science.

CO-PO Mapping

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

Syllabus

Machine learning – Regression, Classification and Kernel Learning, Deep learning Fundamentals – Common Neural Networks architectures, Explaining Predictions, Application of Machine learning and Neural networks in materials science – Unsupervised learning of material spaces, Kernel Ridge Regression for materials property Prediction, Deep learning for sequences, Predicting DFT energies with GNN, Gaussian Approximation Potentials

and machine learning of force field, cmlkit – Toolkit for machine learning for Material science and Quantum Chemistry.

Text Books / Reference

'Deep Learning for Molecules and Materials', Andre white, [online], https://dmol.pub/intro.html.

'Machine learning in materials science: Recent progress and emerging applications,' Kusne, A., Mueller, T. and Ramprasad, R., Reviews in Computational Chemistry (2016), [online], https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=915933.

'Machine learning for quantum mechanics in a nutshell', Rupp, M. International Journal in Quantum Chemistry, 2015, 115, 1058– 1073. DOI:10.1002/qua.24954.

Nomad Tutorials . https://nomad-lab.eu/prod/v1/gui/analyze/tutorials

Recent Publications for AI in Material Science. https://archive.materialscloud.org/

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE453	COMPUTATIONAL DRUG DESIGN	L-T-P-C: 2-0-3-3

Course Objectives

- The main objective of this course is to explore computer assisted drug design.
- The course focus on pharmacopore mapping associated with combinatorial chemistry.

Course Outcome

After completing this course, the students will be able to

CO1: Analyse the molecular modelling and computational formats for representing Chemicals.
CO2: Evaluate the open-source tools available for computer assisted drug design.
CO3: Analyse databases available for lead molecules and understand the developmental process.
CO4: create automated pipelines for computer assisted drug design.

CO-PO Mapping

PO/PSO															

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

Syllabus

Unit 1

Introduction to Cheminformatics, ADME Database, Chemical, Biochemical and Pharmaceutical Databases. Drug Design and Discovery – Target Identification & validation of lead molecules – Optimisation of Virtual Screening Technique- Drug likeness screening.

Unit 2

Molecular Modelling – Molecular Docking – Denovo Ligand Design & Structure based methods-Concept of pharmacophore mapping and pharmacophore-based Screening – Molecular Docking – Rigid Docking- flexible docking – manual docking – docking based screening – Informatics & Methods in Drug Design.

Textbooks / References

Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008.

Burger's Medicinal Chemistry and Drug Discovery, 6th Edition, Vol. 1. Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 2003.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE454 DEEP LEARNING IN GENOMICS AND BIOMEDICINE L-T-P-C: 2-0-3-3

Course Objectives

- The goal of this course is to cover the overview of the relevant background in genomics.
- The course focuses the ongoing developments in deep learning applications of biomedical data.
- The course visualises the landscape of the genome.

Course Outcome

After completing this course, the students will be able to

CO1: Analyse the computational formats for representing genome.
CO2: Evaluate the open-source tools available for genome assembly.
CO3: Application of deep learning models available for genome annotations.
CO4: Create automated health database.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to deep learning - Applications of deep learning, Application of Deep learning to regulatory genomics-metagenomics-variant scoring and population genetics - probability and statistics.

Unit 2

Applications of deep learning to predicting protein structure and pharmacogenomics - Applications of deep learning to electronic health records and medical imaging data.

Textbooks / References

Polina Mamoshina, Armando Vieira, Evgeny Putin, Alex Zhavoronkov, Applications of deep learning in Biomedicine, Mol.Pharmaceutics, 2016.

Riccardo Miotto, Fei Wang, Shuang Wang, Xiaoqian Jiang, Joel T Dudley, Deep learning for healthcare: review, opportunities and challenges, Briefings in Bioinformatics, Vol.19, Issue.6, 2018.

Tianwei Yue, Haohan Wang, Deep Learning for Genomics: A Concise Overview, Handbook of Deep Learning Applications, Springer, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE455	**DNA SEQUENCING TECHNOLOGIES**	**L-T-P-C: 2-0-3-3**

Course Objectives

- The goal of this course is to cover the overview of DNA Sequencing.
- The course focus on the advancements in nucleic acid sequencing.
- The course emphasizes the interpretable, biological insights obtained from DNA Sequencing.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyse the computational formats for representing read type in the DNA Sequencing.
CO2: Evaluate the open-source tools available for read-interpretations in DNA Sequencing.
CO3: Analyse the recent algorithms for signal-sequence conversion.
CO4: Create automated pipelines for the data analysis of comparative genomics.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to Genome Sequencing – Applying Euler's theorem to assemble genomes - sequencing antibiotics - Introduction to Structural Variation - Advantages of long-read sequencing for structural variation analysis - Application of long-reads to structural variation analysis.

Unit 2

Data Analysis Tools for DNA sequencing - Accurate analysis of targeted genomic regions - Quantifying gene expression and transcriptome analysis - Simultaneous analysis of epigenetic modifications and sequence data – Metagenomic analysis of environmental samples - Applications of nanopore sequencing technologies to whole genome sequencing of human viruses.

Textbooks/References

Sudmant, P.H. et al, An integrated map of structural variation in 2,504 human genomes. Nature. 2015.

Lu, H., Giordano, F. and Ning, Z, Oxford Nanopore MinION Sequencing and Genome Assembly. Genomics Proteomics Bioinformatics, Vol.15, Issue.5, 2016.

Stankiewicz, P. and Lupski, J.R, Structural variation in the human genome and its role in disease. Annu Rev Med. Vol. 61, 2010.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE456	**CRISPR TECHNOLOGY**	**L-T-P-C: 2-0-3-3**

Course Objectives

- The goal of this course is to cover the overview of the relevant background in crispr technology and high-throughput biotechnology, focusing on the available data and their relevance.
- It will then cover the ongoing developments with the focus on the applications of these methods to biomedical data.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyse and learn the discovery of Crisper with emphasis to molecular mechanisms.
CO2: Understand a base knowledge on various application of gene therapy.
CO3: To become familiar with experimental design.
CO4: create automated pipelines for identifying the associations between multiple genome editions.

CO-PO Mapping

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

Syllabus

Introduction to Genetic Engineering - History of Crispr – Crispr in bacteria – Classification of Crispr – General structure of cas9 protein – Mechanism of Crispr cas9 – Applications – Database of Crispr – Case studies.

Textbooks/References

Maximilian Haeussler, Jean-Paul Concordet, CRISPOR Manual, MIT, 2016. Singh et al: A Mouse Geneticist's Practical Guide to CRISPR Applications; Genetics, Vol.199, No.1, 2015.

Ran et al, Genome engineering using the CRISPR-Cas9 system, Nature Protocols, 2013.

Fujihara&Ikawaw, CRISPR/Cas9-Based Genome Editing in Mice by Single Plasmid Injection, Methods Enzymol. 2014.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE457 FULL STACK DEVELOPMENT L-T-P-C: 2- 0- 3- 3

Course Objectives

- Full Stack Development is an indispensable course for computer science students. The course is concerned with end-to-end development of a three-tier web application.
- It deals with the frameworks necessary to implement front-end, back-end and database covering design, development and deployment.
- The course is designed to progress on both front-end and back-end in a synchronized fashion and leverages GitHub and Heroku for version control and deployment.
- The course includes a term project to reinforce the technologies learnt.

Course Outcomes

After completing this course, students will be able to

CO1: Use markup and scripting languages to design and validate dynamic web pages.

CO2: Customize pages for users need based on responsive web design concepts.

CO3: Learn to design appropriate database services based on the requirements.

CO4: Design, develop and deploy an end-to-end web application as a term project.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	3	1	-	-	2	-	2	1	2	1	1
CO2	2	1	1	2	3	1	-	-	2	-	2	1	2	1	1
CO3	3	2	3	2	2	1	-	-	2	-	2	2	2	2	2
CO4	2	2	2	2	2	1	-	-	3	3	3	2	3	3	3

Syllabus

Introduction to web development, Git and GitHub, Taxonomy of frameworks. HTML basics – structuring, positioning, alignment, CSS and JS basics, Browser development tools, Bootstrap basics. Basic Backend App serving text/HTML and HTML from templates. Jinja template, Semantic tags, HTTP components – parameters, headers, cookies, sessions, Handling forms, Serve-Handle JSON/XML requests, Intro to jQuery, jQuery request handling and Ajax, more jinja templating, Lists and tables, DOM styling, Responsive design. Database creation

and connection, Creation of DB Schema from model, Adding relation between models, Intro to REST APIs, Basic CRUD app, Form and tables for CRUD services. Authentication, designing error pages, setup default error pages. Simple hosting on a public web host.

Text Books / References

Laura Lemay, Rafe Colburn, Jennifer Kyrnin, "Mastering HTML, CSS & JavaScript Web Publishing", Paperback, 2016.

Jon Duckett, "Web Design with HTML, CSS, JavaScript and jQuery", Paperback, 2014.

Miguel Grinberg, "The New and Improved Flask Mega-Tutorial", Paperback., 2017.

Kunal Relan, "Building REST APIs with Flask: Create Python Web Services with MySQL", Paperback, 2019.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE458 MOBILE APPLICATION DEVELOPMENT L-T-P-C: 2-0-3-3

Course Objectives

- This is a hands-on elective course which introduces the fundamentals of native android application development using Android Studio.
- The students will learn to customize activities and intents, create rich user interface and manage data on databases such as SQLite.
- The course provides exposure to use various components such as services, async tasks, broadcast receivers and content providers.
- The students also learn to use various APIs such as Maps, Sensors and GPS enabling them to develop ready to use android applications for real-world use cases.

Course Outcomes

After completing this course, students will be able to

CO1: Understand the fundamental concepts of android operating system and android application development.
CO2: Understand the various building blocks of native android applications.
CO3: Design android specific user interface (UI).
CO4: Design and develop applications using android services and sensors.
CO5: Understand and apply data storage and sharing techniques for applications.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2				2								2	3	3
CO2	3	2	2	2	3							3	2	3	3

CO3	2	1	3		3			3	3	3		3	2	3	3
CO4	2	2	2	3	3			3	3	3		3	3	3	3
CO5	3	2	3	3	3			3	3	3		3	2	3	3

Syllabus

Unit 1: Introduction and User Interface
Basics of Android - Android OS architecture, Versions, SDK, API Levels. Set up of mobile app development environment - Understand the app idea and design user interface/wireframes of mobile application - Developing and debugging mobile app components - First application - understanding file structure - layout and resource files - deployment - emulators and devices.
Basic UI design - Button, EditText, TextView, basic event handlers. Activity - Lifecycle, Layouts - Selection components - Radio, checkbox, Date/Time Picker. ListView, Grid view, ScrollView, Image view, Image buttons, Spinner, Toggle, AutocompleteTextView.
Advanced UI design - Intents - Internal/External/Pending, Intent Filters, Android Manifest - Permissions - Fragment, Fragment Lifecycle, Fragment communication - Menu, Notifications, Material Design, Navigation Drawer, WebView.

Unit 2: Components
Data storage - SQLite, Shared Preferences, Internal/External Storage, Room Persistence Library. Background Processing - Services - Started, Bound, Foreground, Intent Service - AsyncTasks. Broadcast receivers, Content Providers, Content resolvers.

Unit 3: Sensors and Location API
Sensors - Motion sensors, Environmental, Position sensors. Touch sensors and Gesture detector. Location Based Services - GPS and Google Maps. Apps with Connectivity to External APIs.

Text Book(s)
Burd B. Android application development all-in-one for dummies. John Wiley & Sons; 2015.

Reference(s)
AndroidDeveloperFundamentalsVersion2, 2018.Accessibleonline: https://developer.android.com/courses/fundamentals-training/overview-v2
Darcey L, Conder S. Sams Teach Yourself Android Application Development in 24 Hours: Sams Teac Your Andr Appl D_2. Pearson Education; 2011.
Hardy B, Phillips B. Android Programming: The Big Nerd Ranch Guide. Addison-Wesley Professional; 2013.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE459	USER EXPERIENCE DESIGN	L-T-P-C 2-0-3- 3

Course Objectives

- This course provides a comprehensive overview of the user experience design process, and is intended to familiarize students with the methods, concepts, and techniques necessary to make user experience design an integral part of developing information interfaces.
- The course provides students with an opportunity to acquire the resources, skills, and hands-on experience they need to design, develop, and evaluate information interfaces from a user-centered design perspective.
- The students of this course will be able to apply the knowledge / learning's from this course to their own professional work as a user experience designer, UX Designers, Information Architects, Usability Engineers etc. in IT domain. They will able to apply learning's in designing the Website design, Mobile applications, Enterprise and consumer software products and applications.

Course Outcomes

After completing this course, students will be able to

CO1: Define the critical issues and theoretical underpinnings of User Experience (UX) design.

CO2: Establish requirements for UX design concepts.

CO3: Develop alternatives for UX design concepts and demonstrate the construction of UX design artifacts.

CO4: Evaluate Ux Design artifacts.

CO5: Learn how Ux design concepts are applied for real life problems.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1							2					2	3	3
CO2	3	1						1					1	3	2
CO3	3	1			3		2						1	3	2
CO4	3	3	3	3	3		2		2	1			2	3	3
CO5	3	3	3		3	2	2	3	2	3		2	2	3	3

Syllabus

Unit 1

Ux Introduction: User Interaction with the products, applications and services – Cognitive Model/Mental Model, Principles of Ux Design, Elements of Ux design - Core elements of User Experience. How these elements work together; Ux Design Process - Defining the UX Design Process and Methodology, Research and Define –

Importance of research, Research methods and tools, Understanding the User Needs and Goals, Understanding the Business Goals, Deliverables of the Research & Define phase, Insight on User Goals and Business Goals.

Unit 2

Ux Design Process Ideate and Design - Visual Design Principles, Information Design and Data Visualizatiion, Interaction Design, Information Architecture, Wireframing & Storyboarding, UI Elements and Widgets, Screen Design and Layouts, Prototype and Test – Need for design testing, Definition of Usability Testing, Types of Usability Testing, Usability Testing Process, Prepare and plan for the Usability Tests, Prototype Design to Test, Introduction of prototyping tools, Conducting Usability Tests, Communicating Usability Test Results.

Unit 3

Ux Design Process Iterate and Improve - Understanding the Usability Test findings, Applying the Usability Test feedback in improving the design, Deliver - Communication with implementation team, UX Deliverables to be given to implementation team, Ux Metrics – Overview, Types of metrics – CSAT, NPS, SUS, TPI, Choosing the right metrics, Future of Ux Design, Case studies: Commuter Rail Mobile App, Medical Patient portal, Ux Tools – Wireframing Ux Design tools such as Pencil, MockPlus, UxPin Usability Testing Tools – Optimizely, ClickHeat, Chalkmark

Text Book(s)

1. Platt D. The Joy of UX: User Experience and interactive design for developers. Addison-Wesley Professional; 2016.

Reference(s)

1. Garrett JJ. The elements of user experience: user-centered design for the Web and beyond (2. painos). Berkeley: New Riders; 2011.
2. Goodman E, Kuniavsky M, Moed A. Observing the user experience: A practitioner's guide to user research. Elsevier; 2012.
3. Buxton B. Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann; 2010.
4. Shneiderman B, Plaisant C. Designing the User Interface: Strategies for Effective Human-Computer Interaction. Pearson Education India; 2010.
5. Tenner E. The Design of Everyday Things by Donald Norman. Technology and Culture; 2015.

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE460	SOFTWARE DESIGN PATTERNS	L-T-P-C 2-0-3- 3

Course Description and Objectives: Design patterns are a general repeatable solution to a commonly occurring software design problem and represent the best practices of experienced object-oriented software designers and developers. Design patterns accelerates the development process by providing time tested solutions that enhance the readability and maintainability of code across a broad spectrum of software developers, designers and architects familiar with patterns. This course provides an overview of the important design patterns and focuses on their applicability to various design problems. This course helps a student with basic knowledge of object-oriented design and programming become a more efficient and effective software professional.

Course Outcomes

After completing this course, students will be able to

CO1: Understand the common software design problems seen in the development process

CO2: Demonstrate the use of various design patterns to tackle these common problems.

CO3: Identify the most suitable design pattern to address a given software design problem.

CO4: Analyze existing code for anti-patterns and refactor the code.

CO5: Apply best practices of design principles for software design and development.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	3	2		2	2	1	2	2	3	3	3
CO2	3	3	3	3	3	3		2	2	3	2	3	3	3	3
CO3	3	3	3	3	3	3		2	2	3	2	3	3	3	3
CO4	3	3	3	3	3	2		2	3	2	1	2	3	3	3
CO5	3	3	3	3	3	2		2	3	2	1	3	3	3	3

Syllabus

Unit 1

Introduction to Design Patterns: Significance – Software Design and patterns – Model – View - Controller.

Unit 2

Observer Pattern - Decorator Pattern - Factory Pattern - Singleton Pattern - Command Pattern - Adapter and Facade Patterns - Template

Method Pattern - Iterator and Composite Patterns – The State Pattern – The Proxy Pattern – Compound Patterns.

Unit 3

GRASP Patterns and Anti-patterns. Case Study: Use of patterns in the Design of a Modern Web Framework.

TEXTBOOK/ REFERENCES:

Erich Freeman, Elisabeth Robson, Bert Bates and Kathy Sierra "Head First Design Patterns", O'Reilly Media Inc., October 2004.

Erich Gamma, Richard Helm, Ralph Johnson and John M. Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Second Edition, Addison Wesley, 2000

James W. Cooper, "Java Design Patterns: A Tutorial", Second Edition, Pearson Education, 2003.

Mark Grand, "Patterns in Java – A Catalog of Reusable Patterns Illustrated with UML", Wiley – Dream tech India, 2002

Evaluation Pattern:

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE461	**CONCURRENT PROGRAMMING**	**L-T-P-C: 2-0-3-3**

Course overview:

The course aims to provide fundamentals of concurrency and expose students to the various concurrent frameworks that includes multi-threaded and parallel frameworks. Although, the content of the course is centred around Java, the underlying concepts are general and applicable irrespective of the languages. The course will provide hands-on exposure to various subtleties in concurrent programming which are key for software developers.

Course Outcome

After completing this course, the students will be able to

CO1: Understand and appreciate the associated with concurrent programming.

CO2: Get a hands-on exposure to a multi-threaded programming framework in Java.

CO3: Get a hands-on exposure to a parallel programming framework in Java.

CO4: Understand the use of concurrent data structures and synchronization utilities

CO-PO Mapping

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

Syllabus

Unit 1

Basic concurrency concepts, problems with concurrent applications – data races, deadlocks, live-locks, resource starvation, priority inversion, Designing concurrent applications – analysis-design-implementation-testing-tuning, Java concurrency API – Threads in Java.

Unit 2

Managing lots of threads – basic components of executor framework, serial vs. coarse grained vs. fine grained concurrency with examples, Concurrency in a client/server environment, Callable and Future interfaces, running tasks divided into phases using Phaser class.

Unit 3

Fork-Join parallel programming framework – Divide-and-conquer, Recursive Action Task, ForkJoinPool, and ExecutorService, Work stealing. Processing massive dataset with Parallel Streams – Concurrent Loader, Concurrent Statistics, Concurrent data structures and synchronization utilities.

Textbooks

Javier Fernández González, Mastering Concurrency with Java 9, Second Edition, Pakt Publishing, July 2017.

Brian Goetz, Java Concurrency in Practice. Addison Wesley, 2010.

Herbert Schidlt, Java Complete Reference, Eleventh Edition, Paperback, 2020.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE462	DEEP REINFORCEMENT LEARNING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course aims to provide the cutting-edge concepts in deep reinforcement learning
- It also helps the students to train an agent which can perform a variety of complex tasks.
- It will also help students to learn about the core challenges and approaches, including generalization and exploration and also make the students well versed in the key ideas and techniques for deep reinforcement learning

Course Outcomes

After completing this course, the students will be able to

CO1: Decide whether a given application problem should be formulated as a Deep Reinforcement Learning (DRL) problem.

CO2: Correctly define the problem formulation, design the most suitable algorithm from the different possible classes of DRL algorithms, providing a justification

CO3: Implement and apply temporal-difference reinforcement learning algorithms

CO4: Apply the multiple criteria for analysing and evaluating the DRL algorithms on the relevant metrics: regret, sample complexity, computational complexity, empirical performance, convergence.

CO5: Implement in code the main DRL algorithms and apply it to solve several practical problems in different application domains, evaluating experimentally their performance

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	3	2	2	3	3	3	3
CO2	3	3	3	3	3	-	-	-	3	2	2	3	3	3	3
CO3	3	3	3	3	3	-	-	-	3	2	2	3	3	3	3
CO4	3	3	3	3	3	-	-	-	3	2	2	3	3	3	3
CO5	3	3	3	3	3	-	-	-	3	2	2	3	3	3	3

Syllabus

Introduction to Deep Reinforcement Learning – Approximate Solution Methods: On-policy Prediction with Approximation – On-policy Control with Approximation – Off-policy Methods with Approximation – Eligibility Traces – Policy Gradient Methods – Applications and Case studies.

Text Books / Reference Books

'Reinforcement Learning', Richard.S.Sutton and Andrew G.Barto, Second edition, MIT Press, 2018

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

22AIE463	**TIME SERIES ANALYSIS**	**L-T-P-C 2-0-3- 3**

Course Objectives

- This course will cover the tools and techniques required to analyse time series data
- The course will focus on the linear time series analysis, nonlinear time series analysis and ML/DL methods for predictive analytics.
- The course will also focus on generating models from non-stationary and stationary time series data.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse linear time series data

CO2: Analyse nonlinear time series data

CO3: Analyse stationary and non-stationary time series data

CO4: Apply ML/DL models to perform predictive analytics on time series data

CO-PO Mapping

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

Syllabus

Unit 1

Introduction – Review of basic statistics – Stationarity – Ergodicity – Autocorrelation – Partial Autocorrelation – Linear Models – Autoregressive Models – Moving Average Models

Unit 2

ARMA – ARIMA – SARIMA – VAR – Conditional Heteroscedastic Models – ARCH Model – GARCH Model

Unit 3

Nonlinear Models – Tests for Stationarity – Tests for nonlinearity – State Space Models

Unit 4

Machine Learning Models – Deep Learning Models –Precursors for Catastrophic Transitions.

Text Books / References

Jonathan D Cryer & Kung Silk Chan, Time Series Analysis With Applications in R, Second Edition, Springer, 2008

Robert H Shumway & David S Stoffer, Time Series Analysis and Its Applications with R examples, Third Edition, Springer,2011

G E P Box, G M Jenkins, G C Reinsel, G M Ljung, Time Series Analysis: Forecasting and Control, fifth edition, Wiley, 2016

Aileen Nielsen, Practical Time Series Analysis Prediction with Statistics and Machine Learning, O'Reilly, first edition, 2019

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30