Integral University, Lucknow

SEMESTER – 3rd

2. Course Name	Artificial Intelligence			L	T	P
3. Course Code	CS442			3	1	0
4. Type of Course (use tick mark)				Core (✓)	DE ( )	FC ( )
5. Pre-requisite (ifany)	none	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. Explain the basic problem-solving techniques, knowledge representation methods and learning methods of Artificial Intelligence.
2. Assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular engineering problems.
3. Understand the role of knowledge representation, problem solving, and learning in intelligent system engineering.
4. Develop intelligent systems by assembling solutions to concrete computational problems.
5. Develop an interest in the field sufficient to take more advanced subjects.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Design an intelligent agent to solve real world problems.
CO2	Identify the best heuristic for problem solving that will lead to find the optimal solution within constraints and adverse conditions.
CO3	Represent knowledge using logic programming, create knowledge base and apply inference mechanisms.
CO4	Apply statistical and probabilistic machine learning techniques for a real-world problem in order to solve it.
CO5	Design and develop an expert system, solve problems using evolutionary programming, using swarm intelligence and develop programs using PROLOG

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction	Mapped CO: 1

Introduction to AI, Current Trends in AI, Intelligent Agents:- Agents and Environments, Nature of Environments, Structure of Agents, Problem Solving, Problem Solving Agents, Example Problems, Searching for Solutions, Uniformed Search Strategies (BFS, DFS, DLS, IDS)

Unit-2	Number of lectures =08	Title of the unit: searching techniques	Mapped CO: 2

Informed (Heuristic) Search Strategies: - Heuristic Function, Greedy best first search, A* search, Local Search Algorithms and Optimization Problems (Hill Climbing & Genetic Algorithm), Introduction to Constraint Satisfaction Problems (CSP), Adversarial Search:- Optimal Decisions in Games (MiniMax algorithm), Alpha – Beta Pruning.

Unit-3	Number of lectures = 08	Title of the unit: knowledge and reasoning	Mapped CO: 3

Introduction to logical Agents, Propositional Logic:- Representation, Syntax and Semantics, Forward Chaining, Backward Chaining, CNF, Resolution, First Order Logic:– Representation, Syntax and Semantics, Inference in First Order Logic:– Unification, Forward Chaining, Backward Chaining, Resolution.

Unit-4	Number of lectures = 08	Title of the unit: learning	Mapped CO: 4

Forms of Learning, Inductive Learning:- Learning Decision Trees, Statistical learning methods:- Naïve bayes models, Bayesian network, EM algorithm, HMM, Instance based learning:-nearest neighbor models

Unit-5	Number of lectures = 08	Title of the unit: intelligent systems	Mapped CO: 5

Expert System- Stages in the Development of an Expert System, Difficulties in Developing Expert System, Application of Expert System, Introduction to Evolutionary Programming, Swarm Intelligent Systems, Introduction to PROLOG.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1											
CO2	3	3	3						1				1		
CO3	1	2	1												
CO4			1												
CO5	2	2								2		1			

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence – A Modern Approach", 2nd Edition, Pearson Education / Prentice Hall of India, 2004.
2. George F. Luger, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", Pearson Education PHI, 2002.
3. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd., 2000.
4. N.P. Padhy, "Artificial Intelligence and Intelligence systems", Oxford Press.

2. Course Name	**Integration Project Lab**			**L**	**T**	**P**
3. Course Code	**CS631**			0	0	8
4. Type of Course (use tick mark)				**Core (✓)**	**DE ( )**	**FC ( )**
5. Pre-requisite (ifany)	none	**6. Frequency (use tickmarks)**	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures =0		**Tutorials = 0**		**Practical = 8**		

8. COURSE OBJECTIVES: The aim of the Joint Interdisciplinary Project is to prepare students to contribute to solving impactful technological challenges. The projects not only demand good engineering working knowledge but also experience with interdisciplinary and systems theory, and both knowledge and mindsets of innovation and entrepreneurial behavior. Teams of interdisciplinary student teams guided by a coach and offered academic and industry expertise, are invited to realize an innovative problem solution to a complex problem and contributing to the sustainable development goals.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	Cognitive abilities attributable to interdisciplinary learning • Demonstrate the ability to engage in perspective-taking; • Develop structural knowledge pertaining to the problem; • Integrate knowledge and modes of thinking drawn from two or more disciplines; • Produce an interdisciplinary understanding of complex problem or intellectual question.
CO2	Scientific and intellectual development • Capable to analyse scientific and societal consequences (economic, social, cultural, environmental) of the innovation;
CO3	Research and design capabilities • Demonstrate engineering skills: technical skills, interpreting results, creativity, usability for company/institute; • Demonstrate that they are capable to independently apply relevant theory and/or knowledge to research and/or design;
CO4	Collaboration and communication in an interdisciplinary team • Demonstrate behavioural competences and skills: taking initiative, responsibility, showing communication skills, independency, collaboration and the ability to respect different disciplines and adapt to different cultures); • Show ability to write a technical report: structured/consistent, language proficient, with correct use of literature/references, use of figures/tables/equations, and has a concise format (30 pages); • Present work performed in a structured way through an oral presentation to their peers and customer.
CO5	Self-adjustment and reflection capabilities • Plan and control the project efficiently considering resources and methodology; • Being able to reflect on personal functioning in an evaluation report: reflect on personal objectives, indicate personal strengths/weaknesses. Indicate future personal improvement, drawing conclusions for future career.
CO6	Cognitive abilities attributable to interdisciplinary learning; • The ability to integrate (scientific and practical technological) knowledge from different disciplines to solve complex problems Scientific and intellectual development • The capacity to evaluate the ethical, scientific and societal consequences of the proposed innovation Research and design capabilities • The ability to create reasonable and relevant research or design, according to the academic standards of the involved disciplines Collaboration and communication in an interdisciplinary team • Demonstrate behavioural competences and skills relevant for teamwork and effective communication with different stakeholders. Self-adjustment and reflection capabilities • To carry out regular reflections on professional and personal development and being able to improve upon those reflections • Understand contemporary and societal issues in their work.

10. detailed content

Project **Number of Lectures 40**

The course is not divided into Units. The course comprises of interdisciplinary work, scientific reasons and ethical mindset, innovation process, presentation and communication.

11. CO-PO and PSO mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	3	1	1	1	2	2	2	1	2	1	2	3	3
CO2	1	1	2	3	3	2	1	2	3	1	1	1	1	1	1
CO3	3	3	2	1	2	3	2	3	3	2	2	1	3	3	3
CO4	1	1	1	1	2	2	3	3	3	1	3	1	1	1	1
CO5	3	1	1	2	2	3	2	2	3	2	1	1	1	1	1

CO6	1	1	1	3	3	3	3	3	2	2	1	1	1	1	1

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

2. Course Name	**Machine Perception**			**L**	**T**	**P**
3. Course Code	**CS632**			3	1	0
4. Type of Course (use tick mark)				**Core (✓)**	**DE ( )**	**FC ( )**
5. Pre-requisite (ifany)	CS-272 Python Programming Lab, CS-544 Machine Learning Techniques	**6. Frequency (use tickmarks)**	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	**Tutorials = 1**	**Practical = 0**

8. COURSE OBJECTIVES: This course provides an overview of machine perception techniques in robotics

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	**ATTRIBUTES**
CO1	explain the role of Machine Perception (MP) in Robotics, and describe possible applications
CO2	explain the measurement principles of the relevant sensors, explain the principles of well-established methods for low- to high-level sensor processing
CO3	Analyze an MP problem, consider available sensor and computational resources, and select the appropriate MP methods to apply
CO4	write Python code in relevant frameworks to visualize data and implement MP methods, perform MP experiments, evaluate the results, and draw sound conclusions

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Introduction**	**Mapped CO: 1**

Machine perception in robotics, Course organization, Overview sensors (camera, radar, LiDAR, tactile), 3D Machine vision: Perspective camera model, Extrinsic and intrinsic camera transformations, Image matching, Stereo vision

Unit-2	**Number of lectures =08**	**Title of the unit: Sensors**	**Mapped CO: 2**

Radar, Lidar and Tactile sensing

Unit-3	**Number of lectures = 08**	**Title of the unit: Object Detection and Classification**	**Mapped CO: 3**

Detection vs. Classification, Object proposals, Handcrafted features (e.g. HOG) & classification (e.g. linear SVM), End-to-end learning: Neural Networks, Performance metrics: confusion matrices, precision vs. recall, ROC curves

Unit-4	**Number of lectures = 08**	**Title of the unit: State estimation**	**Mapped CO: 4**

Bayesian Filtering, Kalman Filtering, Particle Filtering, Object Tracking, Data Association, Track Management

Unit-5	**Number of lectures = 08**	**Title of the unit:Self-Localization & Sensor Fusion**	**Mapped CO: 5**

Absolute vs. relative localization, Ego-motion compensation (e.g. odometry, ICP algorithm), Extrinsic sensor calibration, Environment representations (grids, voxels)

11. CO-PO and PSO mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	1	1	1	2	1	1	1	1	2	2	2	2	3	1
CO2	2	2	2	1	2	1	2	1	1	2	2	2	2	2	1
CO3	3	3	2	1	1	1	1	1	1	2	3	3	3	3	1
CO4	3	3	3	1	1	1	1	1	2	2	3	2	3	3	1

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Slides, Handouts and Jupyter Notebooks

2. Course Name	Ad Hoc Sensor Networks			L	T	P
3. Course Code	CS603			3	1	0
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ( )
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. To understand the basics of Ad-hoc & Sensor Networks.
2. To learn various fundamental and emerging protocols of all layers.
3. To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
4. To understand the nature and applications of Ad-hoc and sensor networks

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Identify different issues in wireless ad hoc and sensor networks
CO2	To analyze protocols developed for ad hoc and sensor networks..
CO3	To identify and address the security threats in ad hoc and sensor networks.
CO4	Establish a Sensor network environment for different type of applications.
CO5	To understand various security practices and protocols of Ad-hoc and Sensor Networks

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit:Introduction of ad-hoc/sensor networks	Mapped CO: 1

Key definitions of ad-hoc/sensor networks, Advantages of ad-hoc/sensor networks, Unique constraints and characteristics of MANET, challenges & Performance parameters of Adhoc networks, Types & Applications of MANETs, Introduction of sensor network, sensor networks vs. ad-hoc networks, sensor network limitations, Design issues.

Unit-2	Number of lectures =08	Title of the unit: Routing in Ad Hoc Networks	Mapped CO: 2

Introduction, Topology based routing protocol- Proactive routing- DSDV, WRP, TBRPF, OLSR, multipoint relay, STAR, Reactive routing- DSR, AODV, TORA, Hybrid routing approach- ZRP, FSR, LANMAR, CBRP, Position based routing- Location services- DREAM, quorum based location service, GLS, home zone, forwarding strategies- greedy packet forwarding, Restricted Directional flooding- DREAM, LAR, RDMAR, Hierarchical routing, Other position based routing protocols.

Unit-3	Number of lectures = 08	Title of the unit: Wireless sensor networks	Mapped CO: 3

Design Issues, Challenges of Wireless sensor network, Energy consumption, Clustering of sensors- regularly placed sensor, randomly distributed sensors, Heterogeneous WSNs. Mobile Sensors, attacks on sensor network routing- Spoofed, altered, or replayed routing information, selective forwarding, sinkhole attacks, the Sybil attack, Wormholes, HELLO flood attacks, Acknowledgement spoofing, application of sensor networks.

Unit-4	Number of lectures = 08	Title of the unit: Data retrieval in sensor networks	Mapped CO: 4

Introduction, Classification of WSNs- Architecture of sensor networks, network architecture, Routing Layer- Network structure based- flat routing- Directed diffusion, sequential assignment routing, MCFA, coherent and non-coherent processing, energy aware routing, Hierarchical routing- CBRP, LEACH, PEGASIS, MECN, TEEN, APTEEN, routing in fixed size clusters, sensor aggregates routing, Hierarchical power- Aware routing, flat versus Hierarchical.

Unit-5	Number of lectures = 08	Title of the unit: Security	Mapped CO: 5

Introduction, distributed system security, security in Ad- Hoc networks- requirements, security solutions constraints, challenges. Key Management- background, Diffie-Hellman key agreement, N- Party Diffie- Hellman Key agreement, The tree based generalized Diffie-Hellman protocol, Cooperation in MANETS, WSN security, Key distribution and management, Requirements for bootstrapping security in sensor networks, key distribution techniques in sensor networks- using a single network-wide key, using pair wise-shared keys, random key pre-distribution scheme, security protocols for sensor network, general consideration of using public key method, SPINS: SNEP AND µTELSA.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1		3	3	3	3		2	3	2	3	2		1	2
CO2		2		2	1	3	3		1				3		
CO3	3		3	1	2			1		2	3	1	2	3	3
CO4		2	2	3		2	3		2	3	1	3	1	2	1
CO5	2		1			3	1		2		2		3	3	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. AD HOC & SENSOR NETWORK "Theory and Application" by Carlos de MoraisCordeiro, World scientific press.
2. "Wireless Ad Hoc and Sensor Networks" by HoudaLabiod, Willy Publication

2. Course Name	Modern Control			L	T	P
3. Course Code	EE610			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. To learn the concept and dynamics of the process
2. To get the knowledge of controllers
3. To design the controller based on the model of the process
4. To apply advanced control schemes
5. To apply robust control scheme

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to understand different types of models of the system.
CO2	Students will have the knowledge of PID controller and its variants.
CO3	Students will be industry ready by designing the controller using model-based techniques
CO4	Students will be able to apply model predictive technique
CO5	Students will be able to apply robust sliding mode control technique

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Review of classical feedback control	Mapped CO: 1

The control problem, Transfer functions, Deriving linear models, First order and second order stable and unstable system models, process with time delays, Approximation of higher order transfer function, difficulties associated with the control of unstable, integrating and non-minimum phase system.

Unit-2	Number of lectures =08	Title of the unit: Control actions and controllers	Mapped CO: 2

Classification of control systems, proportional-integral-derivative (PID) control, different forms of PID, Degree of Freedom analysis, Objective of controller design, meaning of servo and regulatory control.

Unit-3	Number of lectures = 08	Title of the unit: Model based design methods	Mapped CO: 3

Introduction to controller design methods, open loop and closed loop methods, model based tuning methods: direct synthesis method, internal model control. Performance and stability analysis.

Unit-4	Number of lectures = 08	Title of the unit: Model Predictive control	Mapped CO: 4

Review of single input single output (SISO) control; model-based control; multivariable control strategies, model forms for model predictive control, model forms for model predictive control, Predictive control strategy, prediction model

Unit-5	Number of lectures = 08	Title of the unit: Sliding mode control	Mapped CO: 5

Notion of variable structure systems and sliding mode control, Design continuous sliding mode control, Design of discontinuous sliding mode control, chattering issue, Introduction to higher order sliding mode control.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	2		1						2		1	2	2	
CO2	3	2	1	2						2		3	3	2	
CO3	2	3		1								2	2	3	
CO4	1	2		3								3	2	2	
CO5	2	2	3		2							3	2		

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Seborg, D, E, Edgar, T. F., Millechamp, D, A., Doyle III, F, J., Process Dynamics and Control, John Wiley & Sons., 2016
2. B. W. Bequette, Process Control Modelling Design and Simulation (2003).
3. I. J. Nagrath& M. Gopal, "Control system engineering", New Age International, 4th Edition, 2015.
4. Rao, A. Ramachandro. Process Control Engineering. Routledge, 2022.
5. Bhattacharyya, Shankar P., and Lee H. Keel. Linear Multivariable Control Systems. Cambridge University Press, 2022

2. Course Name	Virtual Reality			L	T	P
3. Course Code	CA565			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES: This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Describe how VR systems work and list the applications of VR.
CO2	Understand the design and implementation of the hardware that enables VR systems tobe built
CO3	Understand the system of human vision and its implication on perception and rendering
CO4	Explain the concepts of motion and tracking in VR systems
CO5	Describe the importance of interaction and audio in VR systems

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction to Virtual Reality	Mapped CO: 1

Introduction to Virtual Reality: Fundamental concept and components of Virtual Reality, Primary features and Present development in Virtual Reality, Modern experiences, Historical Perspective, Needs of VR, Bird's-Eye View, Hardware, Sensors, Displays, Software, Virtual World Generator, Game Engines, Human Senses, Perceptual Psychology, Psychophysics. Examples of VR Systems

Unit-2	Number of lectures =08	Title of the unit: Multiple Models of Input and Output Interface	Mapped CO: 2

Multiple Models of Input and Output Interface in Virtual Reality Input: Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus and 3D Scanner etc. Output: Visual /Auditory / Haptic Devices

Unit-3	Number of lectures = 08	Title of the unit: Visual Computation in Virtual Reality	Mapped CO: 3

Visual Computation in Virtual Reality: Fundamentals of Computer Graphics, Software and Hardware technology on Stereoscopic Display. Advanced Techniques in Computer Graphics: Management of Large Scale Environments and Real Time Rendering.

Unit-4	Number of lectures = 08	Title of the unit: Interactive Techniques in Virtual Reality:	Mapped CO: 4

Interactive Techniques in Virtual Reality: Body Track, Hand Gesture, 3D Manus, Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR, X3D Standard, Vega, MultiGen, Virtools etc.

Unit-5	Number of lectures = 08	Title of the unit: Application of Virtual Reality in Digital Entertainment:	Mapped CO: 5

Application of Virtual Reality in Digital Entertainment: Virtual Reality Technology in Film and TV Production, Virtual Reality Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by Virtual Reality

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1		1										1		1	
CO2	1		1									2			
CO3				1		1								1	
CO4	2					1					2	1		1	
CO5			3	2									2	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.

2. Course Name	System Simulation and Modeling			L	T	P
3. Course Code	CS607			3	1	0
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ()
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. Define the basics of simulation modelling and replicating the practical situations in organizations
2. Develop simulation model using heuristic methods.
3. Generate random numbers and random variates using different techniques.
4. Analysis of Simulation models using input analyser, and output analyser
5. Explain Verification and Validation of simulation model.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.
CO2	Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
CO3	Interpret the model and apply the results to resolve critical issues in a real world environment.
CO4	Apply random number variates to develop simulation models
CO5	Analyze output data produced by a model and test validity of the model

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction to Virtual Reality	Mapped CO: 1

Systems, Modelling, Simulation. Simulation as a tool, Advantages and Disadvantages of Simulation, Areas of Application, Classification of simulation models, continuous simulation, combined continuous-discrete simulation, Discrete-Event System Simulation, Monte Carlo Simulation. Steps of Simulation Study.

Unit-2	Number of lectures =08	Title of the unit: Multiple Models of Input and Output Interface	Mapped CO: 2

Introduction to Modeling, Modeling Concepts and Definitions. Model of a System, Types of Models. Linear models, Nonlinear Functions Quadratic program model, Nonlinear modeling examples, Unconstrained and constrained growth models, Curve fitting, Stochastic models. Modelling complex system. Accuracy and precision in modelling.

Unit-3	Number of lectures = 08	Title of the unit: Visual Computation in Virtual Reality	Mapped CO: 3

Basic Probability and statistics: Random Variables, Properties of Random Numbers, Generation of Pseudo- Random Numbers. Techniques for Generating Random Numbers. Tests for Random Numbers. Stochastic Processes. Means, Variances and Correlations. Probability Distribution. Confidence intervals and hypothesis test.

Unit-4	Number of lectures = 08	Title of the unit: Interactive Techniques in Virtual Reality:	Mapped CO: 4

Types of Simulations with Respect to Output Analysis. Stochastic Nature of Output Data. Measures of Performance and Their Estimation. Output Analysis for Terminating Simulations, Output Analysis for Steady-State Simulations. Simulation Tools, Model Input. High-Level Computer- System Simulation, CPU Simulation, Memory Simulation.

Unit-5	Number of lectures = 08	Title of the unit: Application of Virtual Reality in Digital Entertainment:	Mapped CO: 5

Verification of Simulation Models, Calibration and Validation of Models. Increasing Model Validity and Credibility. Simulation Softwares: Simulation package vs programming languages, classification, features, General purpose simulation package, object-oriented simulation, application. Overview of commonly used simulation systems.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1		1						1		1	
CO2	2	3	2	2	2	2	1		1			2			1
CO3	1	2	1		2	1						1		1	
CO4	2	2			2							1		1	
CO5					1							1	2	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Averill M. Law, W. David Kelton, "Simulation Modelling and Analysis" Third Edition, McGraw Hill.
2. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, "Discrete- Event System Simulation", Third Edition, Prentice-Hall India
3. Geoffrey Gordon, "System Simulation", Second Edition, Prentice-Hall India.

2. Course Name	Deep Learning			L	T	P
3. Course Code	CS634					
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ()
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. To understand the basic ideas and principles of Neural Networks
2. To understand the basic concepts of Big Data and Statistical Data Analysis
3. To familiarize the student with The Image Processing facilities like Tensorflow and Keras
4. To appreciate the use of Deep Learning Applications
5. To understand and implement Deep Learning Architectures

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand basics of deep learning
CO2	Implement various deep learning models
CO3	Realign high dimensional data using reduction techniques
CO4	Analyze optimization and generalization in deep learning
CO5	Explore the deep learning applications

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction	Mapped CO: 1

Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression)- Intro to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation, and stochastic gradient descent- Neural networks as universal function approximates

Unit-2	Number of lectures =08	Title of the unit: Deep Networks	Mapped CO: 2

History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks Convolutional Networks- Generative Adversarial Networks (GAN), Semi-supervised Learning

Unit-3	Number of lectures = 08	Title of the unit: Dimensionality Reduction	Mapped CO: 3

Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet - Architectures – AlexNet, VGG, Inception, ResNet - Training a Convnet: weights initialization, batch normalization, hyper parameter optimization

Unit-4	Number of lectures = 08	Title of the unit: Optimization and Generalization	Mapped CO: 4

Optimization in deep learning– non-convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning - Computational & Artificial Neuroscience

Unit-5	Number of lectures = 08	Title of the unit: Case Study and Applications	Mapped CO: 5

Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec - Joint Detection Bioinformatics- Face Recognition- Scene Understanding- Gathering Image Captions

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1		1	2	2	2	2	1	1	1	1	
CO2	2	3	2	2	2	2	1	1	1	2	2	2	1		1
CO3	1	2	1		2	1	2	2	1	1	2	1	2	1	
CO4	2	2			2		2	1	2	1	1	1	1	1	
CO5					1		2		1	2	1	1	2	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. CosmaRohillaShalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
2. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
3. Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, 2016.
4. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

2. Course Name	Internet of Things			L	T	P
3. Course Code	CS626			3	1	0
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ()
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. To understand the fundamentals of Internet of Things.
2. To build a small low-cost embedded system using Arduino / Raspberry Pi or equivalent boards.
3. To apply the concept of Internet of Things in the real-world scenario
4. Develop web services to access/control IoT devices.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	As per the new technology, a student should perform data transfer operations using IOT that help the students to guide in a formal way to communicate over new IOT devises within a short span of time.
CO2	For a given situation, a student should be able to deal with different structural aspects of designing and he/she can know the use of key technologies that would be used by the students to promote the development of a coherent learning program.
CO3	With the enhancement in technology, IOT deals with the challenges and unique product codes for a particular product so a student should be able to tackle the unique codes and he/she should development different approaches that can continue the legacy of an organization.
CO4	During clustering phenomena, a student should be prepared to deal with principles and policies governed according to the company rules so as to provide better identity management using different models like isolated and federated user identity models.
CO5	A student should know the basic idea of security requirements and vulnerabilities in IOT. He/she should be good enough to deal with the establishment of identity for smart applications to be used in IOT

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction	Mapped CO: 1

Introduction Characteristics Physical Design Protocols Logical Design Enabling technologies IoT Levels Domain Specific IoT vs M2M.

Unit-2	Number of lectures =08	Title of the unit: IOT Design	Mapped CO: 2

IoT systems management IoT Design Methodology Specifications Integration and Application Development

Unit-3	Number of lectures = 08	Title of the unit: IOT with Raspberry Pi	Mapped CO: 3

BUILDING IOT WITH RASPBERRY PI Physical device Raspberry Pi Interfaces Programming APIs / Packages Web services

Unit-4	Number of lectures = 08	Title of the unit: IOT with Galileo/Arduino	Mapped CO: 4

BUILDING IOT WITH GALILEO/ARDUINO
Intel Galileo Gen2 with Arduino Interfaces Arduino IDE Programming APIs and Hacks

Unit-5	Number of lectures = 08	Title of the unit: Advanced Topics	Mapped CO: 5

case studies and advanced topics Various Real time applications of IoT Connecting IoT to cloud Cloud Storage for Iot Data Analytics for IoT Software & Management Tools for IoT

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2							2	2	3	
CO2	3	3	3	2	1				1			2	2	3	
CO3	3	2	1	2	2								2	3	2
CO4	3	2	1	2	3					1	2	2	2	1	2
CO5	3	3	2	1	2	1						2		3	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014.
2. ArshdeepBahga, Vijay Madisetti, “Internet of Things A hands on approach”, Universities Press, 2015.

2. Course Name	Agile Software Engineering			L	T	P
3. Course Code	CS605			3	1	0
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ( )
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

This subject will introduce the principles and practices of Agile Project Management and DevOps. Over the recent years the agile movement has spread through the software development community and other organizations both large and small. The emphasis is on software development, but the principles can be applied to any type of project.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Be able to compare and contrast the differences between Agile and other project management methodologies
CO2	Be able to interpret and apply various principles, phases and activities of the Scrum methodology
CO3	Be able to understand Agile Testing principles for real life situations and learn the basics of SAFe for scaled agile
CO4	Be able to identify and use various tools for Agile development and CI/CD
CO5	Be able to understand and implement DevOps principles for CI/CD

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Agile	Mapped CO: 1

Why Agile? Understanding Success, Beyond Deadlines, The Importance of Organizational Success, Enter Agility, How to Be Agile? Agile Methods Don't Make Your Own Method, The Road to Mastery, Find a Mentor.

Unit-2	Number of lectures =08	Title of the unit: Understanding XP:	Mapped CO: 2

Understanding XP: The XP Lifecycle, The XP Team, XP Concepts, Adopting XP: Is XP Right for Us? Go! Assess Your Agility.

Unit-3	Number of lectures = 08	Title of the unit: Practicing XP:	Mapped CO: 3

Practicing XP: Thinking: Pair Programming, Energized Work, Informative Workspace, Root-Cause Analysis, Retrospectives, Collaborating: Trust, Sit Together, Real Customer Involvement, Ubiquitous Language, Stand Up Meetings, Coding Standards, Iteration Demo, Reporting, Releasing: "DoneDone", No Bugs, Version Control, Ten- Minute Build, Continuous Integration, Collective Code Ownership, Documentation, Planning: Vision, Release Planning, The Planning Game, Risk Management, Iteration Planning, Slack, Stories, Estimating, Developing: Incremental Requirements, Customer Tests, Test-Driven Development, Refactoring, Simple Design, Incremental Design and Architecture, Spike Solutions, Performance Optimization, Exploratory Testing.

Unit-4	Number of lectures = 08	Title of the unit: Mastering Agility	Mapped CO: 4

Mastering Agility: Values and Principles: Commonalities, About Values, Principles, and Practices, Further Reading, Improve the Process: Understand Your Project, Tune and Adapt, Break the Rules, Rely on People: Build Effective Relationships, Let the Right People Do the Right Things, Build the Process for the People, Eliminate Waste: Work in Small, Reversible Steps, Fail Fast, Maximize Work Not Done, Pursue Throughput.

Unit-5	Number of lectures = 08	Title of the unit: Deliver Value	Mapped CO: 5

Deliver Value: Exploit Your Agility, Only Releasable Code Has Value, Deliver Business Results, Deliver Frequently, Seek Technical Excellence: Software Doesn't Exist, Design Is for Understanding, Design Tradeoffs, Quality with a Name, Great Design, Universal Design Principles, Principles in Practice, Pursue Mastery.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO2	2	2	1	1	1	1	1	1	1	1	1	2	1	1	1
CO3	3	1	1	1	1	1	2	2	2	1	1	3	2	3	2
CO4	2	2	1	2	2	2	2	2	1	1	1	2	3	2	2
CO5	2	2	2	1	1	1	1	1	1	1	2	1	2	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. The Art of Agile Development (Pragmatic guide to agile software development), James shore, Chromatic, O'Reilly Media, Shroff Publishers & Distributors, 2007.
2. Agile Software Development, Principles, Patterns, and Practices, Robert C. Martin, Prentice Hall; 1st edition, 2002
3. Agile and Iterative Development A Manger's Guide", Craig Larman Pearson Education, First Edition, India, 2004.

2. Course Name	Engineering Product Design			L	T	P
3. Course Code	ME308			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =4	Tutorials = 0	Practical = 0

8. COURSE OBJECTIVES:

1. To impart basic concepts of engineering product design and their applications.
2. To impart knowledge about idea generation and creativity used in the development of a product.
3. To let understand the use of economical aspect in product design.
4. To impart concepts related to reliability and ergonomics.
5. To impart basic knowledge about literature search, patents, standards, and codes.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Explained the basic concepts of engineering product development design and their applications. Also discussed the Design definitions, the role and nature of design, old and new design methods, Design by evolution. Physical reliability & Economic feasibility of design concepts.
CO2	Demonstrate about Morphology of Design. Divergent, transformation and convergent phases of product design.
CO3	Demonstrate the use of economical aspect in product design. Students come to know about utility concept, Utility value, Utility index, Fixed and variable costs. Break-even analysis.
CO4	Demonstrate the concepts of Reliability considerations in product design and the role of Ergonomic aspects in better design of a product.
CO5	Explained about the Information and literature search, patents, standards, and codes. Environment and safety considerations.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit:Introduction	Mapped CO: 1

Explained the basic concepts of engineering product development design and their applications. Also discussed the Design definitions, the role and nature of design, old and new design methods, Design by evolution. Physical reliability & Economic feasibility of design concepts.

Unit-2	Number of lectures =08	Title of the unit: Morphology	Mapped CO: 2

Demonstrate about Morphology of Design. Divergent, transformation and convergent phases of product design.

Unit-3	Number of lectures = 08	Title of the unit: Economic aspect	Mapped CO: 3

Demonstrate the use of economical aspect in product design. Students come to know about utility concept, Utility value, Utility index, Fixed and variable costs. Break-even analysis.

Unit-4	Number of lectures = 08	Title of the unit: Reliability	Mapped CO: 4

Demonstrate the concepts of Reliability considerations in product design and the role of Ergonomic aspects in better design of a product.

Unit-5	Number of lectures = 08	Title of the unit: Environmental safety	Mapped CO: 5

Explained about the Information and literature search, patents, standards and codes. Environment and safety considerations.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	2	1	1	1	2	1	1	1	3	1	1
CO2	2	1	1	1	2	1	1	1	2	2	1	2	2	1	1
CO3	1	2	3	1	1	1	1	1	2	1	1	1	1	2	1
CO4	3	3	2	2	1	1	1	1	3	1	1	1	1	1	1
CO5	1	1	1	2	3	2	1	1	1	2	1	1	1	2	1

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Otto. K and Wood, K, Product Design, Pearson Education, 2001.
2. Pahl. G and Beitz. G, Engineering Design, Springer, 1996
3. Ullman. D. G, The Mechanical Design Process, McGraw- Hill, 1997

2. Course Name	Big Data			L	T	P
3. Course Code	CS609			3	1	0
4. Type of Course (use tick mark)				Core ()	DE (✓)	FC ( )
5. Pre-requisite (ifany)	None	6. Frequency (use tickmarks)	Even ( )	Odd (✓)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures =3	Tutorials = 1	Practical = 0

8. COURSE OBJECTIVES:

1. To study the basic technologies that forms the foundations of Big Data.
2. To study the programming aspects of cloud computing with a view to rapid prototyping of complex applications.
3. To understand the specialized aspects of big data including big data application, and big data analytics.
4. To study different types of Case studies on the current research and applications of the Hadoop and big data in industry.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Student must be Able to understand the building blocks of Big Data
CO2	Student must be able to articulate the programming aspects of cloud computing (map Reduce etc.)
CO3	Student must be able to understand the specialized aspects of big data with the help of different big data applications
CO4	Student must be able to represent the analytical aspects of Big Data
CO5	Student must know the recent research trends related to Hadoop File System, Map Reduce and Google File System etc.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit:Data structures in Java	Mapped CO: 1

Data structures in Java: Linked List, Stacks, Queues, Sets, Maps; Generics: Generic classes and Type parameters, Implementing Generic Types, Generic Methods, Wrapper Classes, Concept of Serialization.

Unit-2	Number of lectures =08	Title of the unit: Working with Big Data	Mapped CO: 2

Understanding Hadoop API for MapReduce Framework, Basic programs of Hadoop
MapReduce: Driver code, Mapper code, Reducer code, Record Reader, Combiner, Partitioner

Unit-3	Number of lectures = 08	Title of the unit: Writing MapReduce Programs	Mapped CO: 3

Demonstrate the use of economical aspect in product design. Students come to know about utility concept, Utility value, Utility index, Fixed and variable costs. Break-even analysis.

Unit-4	Number of lectures = 08	Title of the unit: Hadoop I/O	Mapped CO: 4

The Writable Interface, Writable Comparable and comparators, Writable Classes: Writable wrappers for Java primitives, Text, Bytes Writable, Null Writable, Object Writable and Generic Writable, Writable collections, implementing a Custom Writable: Implementing a Raw Comparator for speed, Custom comparators

Unit-5	Number of lectures = 08	Title of the unit: Pig and hive	Mapped CO: 5

Pig Architecture, Evaluating Local and Distributed Modes of Running Pig Scripts, Checking out the Pig Script Interfaces. Hadoop Data with Hive: Saying Hello to Hive, Seeing How the Hive is Put Together, Getting Started with Apache Hive, Examining the Hive Clients, Working with Hive Data Types, Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, Querying and Analyzing Data.

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	1	3				1		1			
CO2	3	3	3	2	1	1		1				3	2		2
CO3	3	2	1	1									1		
CO4		2	2		1					1		2		1	3
CO5	3		1		1		1		2		2		2	1	

3 Strong contribution, 2 Average contribution , 1 Low contribution

12. Brief description of self-learning / E-learning component

13. Books recommended:

1. Big Java 4th Edition, Cay Horstmann, Wiley John Wiley & Sons, INC
2. Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'reilly, Hadoop in Action by Chuck Lam, MANNING Publ.
3. Hadoop: The Definitive Guide by Tom White, 3rd Edition, O'reilly Hadoop for Dummies by Dirk deRoos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss