Integral University, Lucknow

SEMESTER – 2nd

2. Course Name	Field and Service Robot			L	T	P
3. Course Code	CS564			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: Learn the skills for controlling the interaction between robots and poorly structured environments, through force control, visual control, manipulation and cooperation. The tools for modeling, planning and control of self-driving mobile robots (with wheels, drones, legged, underwater).

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Knowledge and Understanding: The course path aims to provide students with the essential methodological tools for modelling, planning and control of autonomous mobile robot systems. The fundamental problems concerning robots with locomotion mechanisms in open spaces, structured and not, are dealt with. The analytical methods acquired by the students are then used to understand the peculiarities in the design of planning techniques and control laws for such robots.
CO2	Applying knowledge and understanding: The student must demonstrate that (s)he is able to apply the methodologies acquired to model, plan and control autonomous-drive robots with different locomotion mechanisms, such as land rovers, drones (in particular quadcopters), underwater robots, quadrupedal and bipedal robots

10. Unit wise detailed content

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

Field and Service Robots, Wheeled Robots, Odometric localization

Unit-2	Number of lectures =10	Title of the unit: Aerial Robotics	Mapped CO: 1

Aerial robotics, drone kinematics, dynamics of a quadcopter, hierarchical control and geometrical control, passive control with external disturbance estimator

Unit-3	Number of lectures = 10	Title of the unit: Underwater robotics	Mapped CO: 2

Underwater robotics, kinematics and dynamics, mixed controller

Unit-4	Number of lectures = 12	Title of the unit: Legged Robots	Mapped CO: 2

Legged robots, kinematics of the floating base, dynamics and centroidal dynamics, stability and criteria, whole-body control, planner, momentum-based estimator.

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	2	1	1	1	1	1	2	2	2	3	3	1
CO2	2	1	3	1	1	1	1	1	1	2	1	1	3	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics – Modeling, Planning and Control, Springer, London, 2009, ISBN 978-1-84628-641-4
2. A. Ollero, B. Siciliano (Eds.), Aerial Robotic Manipulation, Springer, Berlin, 2019, ISBN 978-3-030-12945-3
3. G. Antonelli, Underwater Robots, 3rd Ed., Springer, Berlin, ISBN 978-3-319-02877-4

2. Course Name	Machine Learning: Theory and Methods			L	T	P
3. Course Code	CS544			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: The course curriculum helps to understand the various machine learning methods and approaches. It aims to model learning problems, neural networks, genetic modelling, hypothesis testing, Gibbs algorithm, Bayes theorem and Bayesian Classifiers, probability learning, clustering approaches, associative learning.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Know about the concepts of Learning Problems, Induction, Decision Tree
CO2	Know about the concepts of Neural Networks, Perceptrons, Genetic Algorithms, Boltzmann Machine.
CO3	Know about the concepts of Bayes theorem, Maximum Likelihood Method, Bayesian Classifier
CO4	Know about the concepts of K-means, clustering
CO5	Know about the concept of first order rule set, associative learning

10. Unit wise detailed content

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

Learning Problems Perspectives and Issues Concept Learning Version Spaces and Candidate Eliminations Inductive bias Decision Tree learning Representation Algorithm Heuristic Space Search.

Unit-2	Number of lectures =08	Title of the unit: Neural Networks and Genetic Algorithms	Mapped CO: 2

Neural Network Representation Problems Perceptrons Multilayer Networks and Back Propagation Algorithms Advanced Topics Genetic Algorithms Hypothesis Space Search Genetic Programming Models of Evaluation and Learning

Unit-3	Number of lectures = 08	Title of the unit: Bayesian and Computational Learning	Mapped CO: 3

Bayes Theorem Concept Learning Maximum Likelihood Minimum Description Length Principle Bayes Optimal Classifier Gibbs Algorithm Naïve Bayes Classifier Bayesian Belief Network EM Algorithm Probability Learning Sample Complexity Finite and Infinite Hypothesis Spaces Mistake Bound Model.

Unit-4	Number of lectures = 08	Title of the unit: Instant Based Learning	Mapped CO: 4

K- Nearest Neighbor Learning Locally weighted Regression Radial Basis Functions Case Based Learning.

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

Learning Sets of Rules Sequential Covering Algorithm Learning Rule Set First Order Rules Sets of First Order Rules Induction on Inverted Deduction Inverting Resolution Analytical Learning Perfect Domain Theories Explanation Base Learning FOCL Algorithm Reinforcement Learning Task Q-Learning Temporal Difference Learning.

11. CO-PO and PSO mapping

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

1. Tom M. Mitchell-Machine Learning, Tata McGraw Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin-Introduction to Machine Learning, (Adaptive Computation and Machine Learning), The MIT Press-2004
3. Stephen Marsland-Machine Learning: An Algorithmic Perspective, CRC Press 2009.

2. Course Name	Machine Learning Tools Lab			L	T	P
3. Course Code	CS549			0	0	2
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 = 2

8. COURSE OBJECTIVES:

1. To learn the basic concepts of programming for machine learning.
2. To be able to develop logics which help them to create machine learning programs and applications using Python language.
3. To analyze the datasets using supervised as well as unsupervised algorithms.
4. To learn the training and testing phases of machine learning.
5. After understanding the machine learning they can easily switch analyze various problems.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Able to understand the basic concepts of programming for machine learning.
CO2	Able to design and develop various machine learning programming problems using Python programming concepts.
CO3	Able to analyze and develop machine learning programs and applications.
CO4	Able to develop programs for diverse datasets, domains and dimensionality.
CO5	Able to draw inferences from analyzed dataset.

10. detailed content

List of Experiments

Implementation of the following problem in python programming language

1. Supervised Learning:
   - i. Simple Regression
   - ii. Logical Regression
   - iii. Gradient Descent and Cost Function
   - iv. Logistic Regression (Binary Classification)
   - v. Logistic Regression (Multiclass Classification)
   - vi. Decision Tree Method
   - vii. Support Vector Machine (SVM)
   - viii. Random Forest Method
   - ix. K-Fold Cross Validation
2. Unsupervised Learning:
   - i. K Means Clustering Algorithm
   - ii. Naive Bayes Classifier
   - iii. K nearest neighbors' classification
   - iv. Principal Component Analysis (PCA)

11. CO-PO and PSO mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1
CO2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	1	1	1	1	1	1	1	2	1	1	1	1	1
CO4	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	1	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	C++ LAB			L	T	P
3. Course Code	CA206			0	0	3
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 = 2

8. COURSE OBJECTIVES:

1. To learn the basic concepts and syntax of object-oriented programming.
2. To be able to develop logics which help them to create programs and applications using C++ language.
3. To learn the use of exception handling.
4. To learn the use of methods and threads.
5. After learning the object-oriented programming, they can easily create desktop-based projects.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Use an integrated development environment to write, compile, run, and test simple object-oriented programs.
CO2	Read and make elementary modifications to C++ programs that solve real-world problems.
CO3	Validate input in a C++ program.
CO4	Identify and fix defects and common security issues in code.
CO5	Document a object-oriented programs using C++

10. detailed content

List of Experiments

1. Program illustrating Classes and Objects.
2. Program illustrating use of Operator Overloading.
3. Program illustrating use of Function Overloading.
4. Program illustrating use of Friend function.
5. Program illustrating Inline function, Static Member functions.
6. Program illustrating use of Constructor and various types of Constructors.
7. Program illustrating various forms of Inheritance.
8. Program illustrating use of Virtual functions.
9. Program illustrating how Exception Handling is done.
10. Program implementing various kinds of Sorting algorithms, Search algorithms

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	2	1	1	1	1	3	1	3	2	1	1	1
CO2	3	3	3	2	2	2	2	1	3	1	2	2	1	1	1
CO3	3	2	2	2	1	1	1	1	3	1	2	2	1	1	1
CO4	3	1	1	1	1	1	1	1	1	1	2	1	1	1	1
CO5	3	2	2	1	2	1	1	1	1	1	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	Digital image Processing			L	T	P
3. Course Code	CS529			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 study the image fundamentals and mathematical transforms necessary for image processing.
2. To study the image enhancement techniques
3. To study image restoration procedures
4. To study the image compression procedures

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Review the fundamental concepts of a digital image processing system
CO2	Analyze images in the frequency domain using various transforms.
CO3	Evaluate the techniques for image enhancement and image restoration.
CO4	Interpret Image compression standards and categorize various compression techniques.
CO5	Interpret image segmentation and representation techniques.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Digital Image Fundamentals	Mapped CO: 1

Image Sensing, and Acquisition, Image Sampling and Quantization, Basic Relationship between Pixels. Sensor and Imaging: Imaging Optics, Radiometry of Imaging, illumination sources and techniques, Camera Principles, Color Imaging, Single Sensor Color Imaging and Color Demosaicing, Range Images,3DImaging.

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

Vector Space and Unitary Transforms, Multi-Resolution Signal Representation, Wavelet Decomposition, Scale space and diffusion, Representation of color, Retinex Processing, Markov Random Field Modellings of Images.

Unit-3	Number of lectures = 08	Title of the unit: Non-linear Image Processing	Mapped CO: 3

Median and Order Statistics Filters, Rank-Ordered-Mean Filters and Signal Dependent Rank-Ordered-Mean Filters, Two-dimensional Teager Filters, Applications of nonlinear filters in image enhancement, edge detections, noise removal etc.

Unit-4	Number of lectures = 08	Title of the unit: Image Processing in Biometric Security	Mapped CO: 4

Introduction, Fingerprint Recognition, Face Recognition, Iris Recognition, Vein Pattern Recognition, Multimodal Biometrics Techniques. Biometric System Architecture, Extraction Algorithm, Matching Algorithm, Authentication, Biometric System Evaluation, Privacy issues.

Unit-5	Number of lectures = 08	Title of the unit: Image Processing in Medical Field	Mapped CO: 5

Introduction, CT scan images, MRI, Seeded segmentation methods: Desirable properties, Pixel Based Methods, Contour Based Methods, Geodesic Active Contours, level set method, deformable model, graph based method, Image analysis of retinal images: acquisition, preprocessing.

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	3	2	2	2	3	2	3	2	3	3	3	3
CO2	2	3	2	2	2	3	2	3	3	3	2	2	3	3	2
CO3	2	3	3	3	2	3	2	3	3	3	2	3	1	3	3
CO4	3	3	3	3	3	2	1	1	3	3	3	3	2	3	3
CO5	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. R.C Gonzalez and R.E. Woods, “Digital Image Processing”, Addison Wesley, 1992.
2. A.K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India.
3. Digital Image Processing–M. Anji Reddy, BS Publications.

2. Course Name	Graph Theory & Applications			L	T	P
3. Course Code	CS281			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: Learn the fundamental concepts in graph theory in view of its applications in modern science. Learn to understand and create mathematical proofs, including an appreciation of its significance in computer science. Use the concepts of Graph theory in subsequent courses in the design and analysis of algorithms, computability theory, software engineering and computer systems. Apply concepts of the theory of probability in study of random phenomena, analyzing and interpreting data that involve uncertainties.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Demonstrate the knowledge of fundamental concepts in graph theory, including properties and characterization of graphs and trees.
CO2	Apply models of Graph theory, Probability theory respectively to solve problems of connectivity and uncertainty.
CO3	Analyzing graphs, trees and random phenomena occurring in real life situations using Graph theory.
CO4	Interpret the models of Graph theory, Probability theory for real life and engineering problems.
CO5	Develop efficient algorithms for graph related problems in different domains of engineering and science.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction to Computer Organization & Architecture	Mapped CO: 1

Graphs, Sub Graphs, Walks, Path & Circuits, Connected Graphs, Disconnected Graphs, Operations on Graphs, Euler Graphs, Hamiltonian Paths and Circuits, Trees, Pendant Vertices in Trees, Distance & Centers in Trees; Spanning Trees, Fundamental Circuits. Finding all Spanning Trees of a Weighted Graphs.

Unit-2	Number of lectures =08	Title of the unit: Memory and Processor Organization	Mapped CO: 2

Cut Sets and Cut Vertices, Properties of all Cut Sets in a Graph, Fundamental Circuit & Cut Set, Connectivity and Separability, Network Flows, Isomorphism. Planar Graphs, Combinatorial and Geometric Dual, Kuratowski's two Graph, Detection of Planarity

Unit-3	Number of lectures = 08	Title of the unit: Hardwired and Micro Programmed Control	Mapped CO: 3

Introduction to Vector Space of a Graph and Vectors, Matrix Representation of Graph: Incidence Matrix and its Sub Matrices, Circuit Matrix and Cut Set Matrix, Path Matrix and Relationship Among Ar, Bf and Cf, Adjacency Matrices, Rank-Nullity Theorem.

Unit-4	Number of lectures = 08	Title of the unit: Parallel and Pipeline Processing	Mapped CO: 4

Coloring, Covering & Partitioning of a Graph: Chromatic Number, Chromatic Partitioning, Chromatic Polynomials, Matching, Covering, Four Color Problem. Directed Graphs: Definitions, Types, Digraphs and Binary Relations

Unit-5	Number of lectures = 08	Title of the unit: High Performance Processors	Mapped CO: 5

Applications of Graph Theory: Analysis and Synthesis of Contact Network, Activity Networks in Project Planning: Analysis of an Activity Network, Graphs in Game Theory, Graphs in Computer Programming.

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	2	1	1	1	1	1	3	2	3	1	2	1
CO2	1	2	1	1	1	1	2	3	1	1	1	1	1	3	1
CO3	1	1	1	1	3	1	3	1	3	1	2	2	3	1	1
CO4	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	2	1	1	1	1	3	1	2	1	3	1	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. Deo Narsingh, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, India, 1974.
2. Bondy J.A. and U.S. Murthy, Graph Theory with Applications, The Macmillan Press Ltd.,1976.
3. Harary F., Graph Theory, Addison-Wesley publishing Co., 1972.

2. Course Name	Advanced Human Computer Interaction			L	T	P
3. Course Code	CS540			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. Develop an awareness of the ways in which Human Computer Interaction theories, methods and techniques guide the development of advanced technologies.
2. Study advanced techniques used to assess the needs of the users of technology.
3. Develop an ability to use these techniques to inform the design and implementation of computer systems.
4. Use research techniques to expand their knowledge of emerging HCI theory.
5. Develop an understanding of the social and ethical issues related to working with people.
6. Apply advanced concepts in HCI to guide research discussions and write research reports.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Explain advanced concepts of Human-Computer Interaction (HCI) as they apply to the design of emerging technology
CO2	Analyse and apply HCI theories and methods that are drawn from the human sciences
CO3	Critically analyze international research projects from the field of HCI.
CO4	Convey ideas related to the field of HCI clearly and fluently in written assignments and through seminar presentations.
CO5	Apply your understanding of the user-centered design process to a specific problem area.

10. Unit wise detailed content

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

Introduction: Course objective and overview, Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering

Unit-2	Number of lectures =08	Title of the unit: Interactive system design	Mapped CO: 2

Interactive system design (theory and practice): GUI design and aesthetics, Prototyping techniques, Model based Design and evaluation: Basic idea, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS), Fitts' law and Hick Hyman's law, Model- based design case studies.

Unit-3	Number of lectures = 08	Title of the unit: Guidelines in HCI	Mapped CO: 3

Guidelines in HCI: Shneiderman's eight golden rules, Norman's seven principles, Nielsen's ten heuristics with example of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough. Empirical research methods in HCI: Introduction (motivation, issues, research question formulation techniques) Experiment design and data analysis (with explanation of one-way ANOVA).

Unit-4	Number of lectures = 08	Title of the unit: Task modeling and analysis:	Mapped CO: 4

Task modeling and analysis: Hierarchical task analysis (HTA), Engineering task models and Concur Task Tree (CTT). Dialog Design: Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and (classical) Petri Nets in dialog design, Cognitive architecture: Introduction to CA, CA types, relevance of CA in IS design, Model Human Processor (MHP).

Unit-5	Number of lectures = 08	Title of the unit: Design -Case Studies	Mapped CO: 5

Design -Case Studies: Case Study 1- Multi Key press Hindi Text Input Method on a Mobile Phone Case Study 2 - GUI design for a mobile phone based Matrimonial. Case Study 3 - Employment
Information System for unorganized construction workers on a Mobile Phone.

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	2	3	1	2	3	2	1	1	1
CO2	1	2	3	1	2	2	2	1	2	1	2	1	1	1	1
CO3	1	3	1	1	1	1	1	1	1	3	1	2	1	1	1
CO4	3	1	2	2	1	1	2	3	1	1	1	1	3	1	1
CO5	1	2	1	1	2	1	2	1	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:

1. Dix A., Finlay J. Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education,2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley,1994.
3. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint)

2. Course Name	Advanced Real Time Systems			L	T	P
3. Course Code	CS527			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: Real-time embedded systems are enabling technologies for many current and future generation applications and are increasingly becoming pervasive. This course aims to provide a good understanding of both fundamental concepts and advanced topics in real-time systems and networks.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Derive the equations of motio Real-time scheduling and schedulability analysis
CO2	Formal specification and verification of timing constraints and properties
CO3	Development and implementation of new techniques to advance the state-of-the-art real-time systems
CO4	Analyse and designed real-time systems and networks
CO5	Knowledge about the course of dimensionality and various methods of dimensions reduction

10. Unit wise detailed content

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

Definition, Structure, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Periodic Task Model, Critical and Non-critical tasks Precedence Constraints

Unit-2	Number of lectures =08	Title of the unit: Real Time Scheduling of Uni- processor systems	Mapped CO: 2

processor systems- Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems. Classical Uniprocessor Scheduling Algo-Rate Monotonic, EDF, Uniprocessor Scheduling of IRIS Tasks: Identical and Non identical Linear & Concave Reward Function, 0/1RewardFunction.

Unit-3	Number of lectures = 08	Title of the unit: Real Time Scheduling of Multi- Processor systems	Mapped CO: 3

Multiprocessor and Distributed System Model, Bin- Packing Assignment Algorithm for EDF, Next-Fit Algorithm for RM Scheduling, Myopic Offline Scheduling, FAB Algorithm & Buddy Strategy.
Real Time Database: Real Time vs. General purpose Database, Main Memory database, Concurrency Control Issues.

Unit-4	Number of lectures = 08	Title of the unit: Real Time Operating Systems	Mapped CO: 4

An overview of RTOS, Real Time Threads, Tasks & Kernels, Case Study of QNX, VRTX, Vx Works.
Fault Tolerance in Real Time Operating Systems- Introduction to Fault, Fault Detection and Error Containment, Redundancy, Data Diversity, Reversal Checks, Malicious & Integrated Failure Handling. Clock Synchronization: Introduction to Clocks.

Unit-5	Number of lectures = 08	Title of the unit: Design - Real Time Communication	Mapped CO: 5

Design -Case Studies: Case Study 1- Multi Key press Hindi Text Input Method on a Mobile Phone Case Study 2 - GUI design for a mobile phone based Matrimonial. Case Study 3 – Employment Information Model of Real Time Communication, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, VTCSMA, Communication in Multicomputer System, N/W Topologies.for unorganized construction workers on a Mobile Phone.

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	3		3		2					2
CO2			2				2				3		2		
CO3		3			1				3	1		1		1	1
CO4	2						1	1			2		1		
CO5			1	2						1			1		

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. C.M. Krishna & Shin, “Real Time Systems”, Mc Graw Hill1985.
2. Jane W.S. LIU, “Real Time Systems”, Pearson Education”.
3. Levi & Agarwal, “Real Time System”, McGraw Hill.
4. Mall Rajib, “Real Time Systems”, Pearson

2. Course Name	Pattern Recognition			L	T	P
3. Course Code	CS523			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 implement pattern recognition and machine learning theories.
2. To design and implement certain important pattern recognition techniques.
3. To apply the pattern recognition theories to applications of interest.
4. To implement the entropy minimization, clustering transformation and feature ordering.
5. To introduce the curse of dimensionality and various methods of dimensions reduction

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Implementation of pattern recognition and machine learning theories.
CO2	Designing and implementing certain important pattern recognition techniques.
CO3	Applying the pattern recognition theories to applications of interest.
CO4	Implementation of the entropy minimization, clustering transformation and feature ordering
CO5	Knowledge about the curse of dimensionality and various methods of dimensions reduction

10. Unit wise detailed content

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

Basic concepts, Applications, Fundamental problems in pattern Recognition system design, Design concepts and methodologies, Examples of Automatic Pattern recognition systems, Simple pattern recognition model. DECISION AND DISTANCE FUNCTIONS -Linear and generalized decision functions, Pattern space and weight space, Geometrical properties, implementations of decision functions, Minimum-distance pattern classifications

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

Probability of events: Random variables, Joint distributions and densities, Movements of random variables, Estimation of parameter from samples. STATISTICAL DECISION MAKING- Introduction, Baye's theorem, Multiple features, conditionally independent features, Decision boundaries, Unequal cost of error, estimation of error rates, the leaving -one-out-techniques, characteristic curves, estimating the composition of populations. Baye's classifier for normal patterns.

Unit-3	Number of lectures = 08	Title of the unit: Non-Parametric Decision Making	Mapped CO: 3

Introduction, histogram, kernel and window estimation, nearest neighbour classification techniques. Adaptive decision boundaries, adaptive discriminate functions, Minimum squared error discriminate functions, choosing a decision-making technique. CLUSTERING AND PARTITIONING- Hierarchical Clustering: Introduction, agglomerative clustering algorithm, the single -linkage, complete-linkage and average-linkage algorithm. Ward's method Partition clustering-Forg's algorithm, K-means's algorithm, Isodata algorithm.

Unit-4	Number of lectures = 08	Title of the unit: Pattern Pre-processing and Feature Selection	Mapped CO: 4

Introduction, distance measures, clustering transformation and feature ordering, clustering in feature selection through entropy minimization, features selection through orthogonal expansion, binary feature selection.

Unit-5	Number of lectures = 08	Title of the unit: Design - Syntactic Pattern Recognition & Application of Pattern Recognition	Mapped CO: 5

Introduction, concepts from formal language theory, formulation of syntactic pattern recognition problem, syntactic pattern description, recognition grammars, automata as pattern recognizers, Application of pattern recognition techniques in bio-metric, facial recognition, IRIS scan, Fingerprints, etc.

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	3		3		2					2
CO2			2				2				3		2		
CO3		3			1				3	1		1		1	1
CO4	2						1	1			2		1		
CO5			1	2						1			1		

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. C.M. Krishna & Shin, "Real Time Systems", Mc Graw Hill1985.
2. Jane W.S. LIU, "Real Time Systems", Pearson Education".
3. Levi & Agarwal, "Real Time System", McGraw Hill.
4. Mall Rajib, "Real Time Systems", Pearson

2. Course Name	Industrial Ergonomics			L	T	P
3. Course Code	ME321			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (if any)	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. Have an ability to apply knowledge of the sciences of human factors and workplace ergonomics.
2. Have an ability to design and conduct experiments, as well as to analyze and interpret data.
3. Have an ability to design a system, component, or process to meet accepted human factors and workplace ergonomics standards within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. Have an ability to function on multi-disciplinary teams.
5. Have an ability to identify, formulate and solve human factors and workplace ergonomics problems.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To identify, formulate and solve human factors and workplace ergonomics problems.
CO2	Have an understanding of professional and ethical responsibility.
CO3	Have the broad education necessary to understand the impact of human factors and workplace ergonomics solutions in a global, economic, environmental, and societal context.
CO4	Have a recognition of the need for, and an ability to engage in, life-long learning.
CO5	Have the knowledge of contemporary issues.

10. Unit wise detailed content

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

Importance applications and principles of occupational ergonomics. 2 Physiological Principles: Muscular work, Nervous control of movements, Improving working efficiency. Optimal use of muscle strength. /Guidelines for work layout. 4 Skilled work: Acquiring skill, control of skilled movements. Design of tools and equipments for skilled work

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

Probability of events: Random variables, Joint distributions and densities, Movements of random variables, Estimation of parameter from : Energy consumption, Efficiency, Heart rate as a measure of workload. 2 Work-station Design: Anthropometric data, Reach and clearance dimensions. Percentiles to be accommodated . STATISTICAL DECISION MAKING- Introduction, Baye's theorem, Multiple features, conditionally independent features, Decision boundaries, Unequal cost of error, estimation of error rates, the leaving -one-out-techniques, characteristic curves, estimating the composition of populations. Baye's classifier for normal patterns.

Unit-3	Number of lectures = 08	Title of the unit: Working Heights:	Mapped CO: 3

Comfortable working postures. Room to grasp or move things, and operate controls. Sedentary work. Its advantages, disadvantages and limitation. Sedentary workplace design. Design of VDT workstations, Design of Key board. 5 Handling Lads: The Human spine, back troubles associated with industrial work, Intervertebral disc, disc pressure, slip of disc, Bio-mechanical models of lower back. Recommendations for handling loads. 3 Man-Machine System: Display equipment, Controls, Relation between control and display instruments, Mental activity, Fatigue, Occupational stress, Job design in monotonous task

Unit-4	Number of lectures = 08	Title of the unit: Human Visual System	Mapped CO: 4

Accommodation, Aperture of the pupil, Adaptation of reline, eye movements Visual capacity, Visual strain, Physiology of reading. 3 Ergonomic Principles of Lighting: Light sources, measurement, physiological requirements of artificial lighting, arrangement of light. Light for fine work and for VDT offices

Unit-5	Number of lectures = 08	Title of the unit: Design - Noise and Violation	Mapped CO: 5

Sound perception, Noise load, damage to hearing, physiological and psychological effects of noise. Protection against noise, Vibrations and their effect on performance. 3 Working Environment: Thermo-regulation in human body, comfort indoors, Air quality and its dryness, Air pollution and ventilation. Heat in industry Recommendations for comfort indoors. Daylight, colours and music for pleasant work environment.

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	2	2	1	2	2	1	1
CO2	1	2	3	1	1	1	1	1	2	1	1	1	1	2	1
CO3	3	3	2	2	1	1	1	1	3	1	1	1	1	1	1
CO4	1	1	1	2	3	2	1	1	1	2	1	1	1	2	1
CO5			1	2						1			1		

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. Fitting the task to the Man, E. Gandjean, Taylor and Francis.
2. A guide to Ergonomics of Manufacturing, Helander, M., East-West Press.
3. Human Factors in Engineering and Design, Sanders, M.S., and Mc Cormik, E.J., McGra

2. Course Name	Advanced Control System			L	T	P
3. Course Code	EE333			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (if any)	Control System EE-301	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 of state space analysis of continuous system.
2. To get the knowledge of state equations, controllability and observability
3. To design the state observer and controller using pole-placement approach
4. To gain information on non-linear control system
5. To evaluate the stability of the system using Lyapunov's stability analysis

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 state model of a system and have the knowledge to find its solution.
CO2	Students will be industry ready by analysis of controllability and observability of the dissimilar system.
CO3	Students will be industry ready by designing the State observer and controller using pole-placement approach
CO4	Students will be able to understand nonlinear system models and analyse its stability.
CO5	Students will be able to analyse system's stability using Lyapunov stability analysis.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: State Space Analysis of Continuous System	Mapped CO: 1

Introduction, Concept of state, Sate variable description, State space representation, state variable representation of continuous system, Conversion of state variable models to transfer function and vice-versa.

Unit-2	Number of lectures =08	Title of the unit: State Equations, Controllability and Observability	Mapped CO: 2

Characteristic equation, state transition matrix, Solution of state equations, Concept of controllability and Observability, Controllable, observable and diagonal canonical form.

Unit-3	Number of lectures = 08	Title of the unit: Pole-Placement Design and State observer	Mapped CO: 3

Concept of pole-placement, Stability improvement by state Feedback, State regulator design, design of state observers and controller.

Unit-4	Number of lectures = 08	Title of the unit: Non-linear Control System	Mapped CO: 4

Types and characteristics of non-linearity, phenomena related to non-linear systems. Phase plane analysis, types of phase portraits, singular points, construction of phase portraits, system analysis by phase-plane method, describing function and its application to system analysis.

Unit-5	Number of lectures = 08	Title of the unit: Lyapunov's Stability analysis	Mapped CO: 5

Concept of Lyapunov's stability, Stability of equilibrium state, asymptotic stability, Lyapunov's stability theorems for continuous systems, methods of generating Lyapunov's function for continuous system, Stability analysis of non-linear system.

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								3			
CO2	2	2											1		
CO3	2	3	1	1								2	3	3	
CO4	1	2		1								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. M. Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill, 4th Edition,2015
2. Ajit K. Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" NewAge International, 5th Edition, 2013.
3. K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.
4. S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.5.
5. B.N. Sarkar "Advanced control system" PHI Learning Pvt. Ltd., 2013.

2. Course Name	Industrial Automation			L	T	P
3. Course Code	EE335			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (if any)	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 improve quality, and reduce human involvement and possibility of human error.
2. To raise the level of safety for personal.
3. To reduce the work piece damage caused by manual handling.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Understand and analyze the concept, design, technique, advancement and application of Automatic Control, Proportional-Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems and Inverse Response Systems
CO2	Understand and analyze the concept, design, technique, advancement, and application of Different types of controllers, Single loop and Multi loop controllers, Hydraulic Control Systems, Industrial Hydraulic Circuit, Pneumatic Control Systems
CO3	Understand and analyze the concept, design, technique, advancement and application of Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes-Computer control of liquid level system, heat exchanger; Smart sensors.
CO4	Understand and analyze the concept, design, technique, advancement and application of Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface
CO5	Understand and analyze the concept, design, technique, advancement and application of Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Industrial Automation Systems	Mapped CO: 1

Introduction, Architecture, Introduction to Automatic Control, Proportional- Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems, and Inverse Response Systems.

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

Different types of controllers, Single loop and Multi loop controllers, Hydraulic Control Systems, Industrial Hydraulic Circuit, Pneumatic Control Systems

Unit-3	Number of lectures = 08	Title of the unit: Programmable logic Controllers (PLC)	Mapped CO: 3

Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes- Computer control of liquid level system, heat exchanger; Smart sensors.

Unit-4	Number of lectures = 08	Title of the unit: Supervisory Control and Data Acquisition (SCADA)	Mapped CO: 4

Introduction, Functional requirements, and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface.

Unit-5	Number of lectures = 08	Title of the unit: Design - Distributed Control System (DCS)	Mapped CO: 5

Evolution, Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS

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	2	3	1	1	1	1	1	1	2	3	2	3
CO2	3	3	1	2	3	1	1	1	1	1	1	2	3	2	3
CO3	3	1	1	2	3	1	1	1	1	1	1	2	3	2	3
CO4	3	1	1	2	3	1	1	1	1	1	1	2	3	2	3
CO5	3	1	1	2	3	1	1	1	1	1	1	2	3	2	3

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. Smith, C.A. and Corripio, A.B. "Principles and practice of automatic process control," Wiley, 3rd edition 1997
2. Johnson, C.D. "Process control instrumentation technology," Prentice-Hall, 8th edition 2008
3. Kalsi, H.S "Electronic Instrumentation" McGraw Hill, 3rd edition 2010

2. Course Name	Six Sigma Methods, Approach & Application			L	T	P
3. Course Code	ME317			3	1	0
4. Type of Course (use tick mark)				Core ()	DE ( )	FC (✓)
5. Pre-requisite (if any)	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. The overarching learning objective of this course is to develop a comprehensive set of skills that will allow the student to function effectively as a Six Sigma introducer.
2. The purpose of Six Sigma course is to gain break-through knowledge on how to improve processes to do things better, faster, and at lower cost.
3. Understanding required defining the metrics behind the operation in an industry to attain the highest level of improvement possible.
4. Understanding project level of a typical industry and manage the project to completion while demonstrating their skill at applying the Six Sigma methodology.
5. The organizational structure body of knowledge includes techniques for both quantitative and non-quantitative analysis, as well as the team leadership skills necessary to get projects across the goal line.

9. COURSE OUTCOMES (CO):

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

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Knowledge related to basic perspectives of quantitative and non-quantitative quality, its role in modern development, continuous improvement using statistical measurements.
CO2	Develop a basic understanding of Six Sigma principles and practices focused by problem solving case studies.
CO3	Identify and apply various techniques to overcome these barriers by understand Six sigma
CO4	methodology and tools.
CO5	Interpret control charts and impact of Six Sigma Projects on customers, suppliers, and stakeholders

10. Unit wise detailed content

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

Quality perception: Introduction to Quality Concept, Quality in manufacturing, Quality in service sector, statistical foundation, and methods of quality improvement. Descriptive statistics: data type mean, median, mode, range, deviation, skewness, and kurtosis. Difference between conventional and six sigma concepts of Quality.

Unit-2	Number of lectures =08	Title of the unit: Basic of six sigma	Mapped CO: 2

Basic of six sigma: concepts of six sigma, defects DPMO, DPU, Z score, attacks on X's, understanding six sigma organization, leadership council, project sponsors and champions, master black belt, black belt and green belts, customer focus, six sigma for manufacturing, six sigma for service, six sigma success stories

Unit-3	Number of lectures = 08	Title of the unit: Methodology of six sigma	Mapped CO: 3

Methodology of six sigma: DMAIC, DFSS, Six sigma tool: project charter, process mapping, measurement system analysis, hypothesis testing, quality function deployment, failure mode and effect analysis, design of experiments

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

Role of control charts, Variable control charts, Attribute control charts, Interpretation of control charts, Process Capability Index, Estimating Capability and Performance Indices, Point Estimate for Capability and Performance Indices, Confidence interval for Capability and Performance Indices, Connection with Tolerance intervals

Unit-5	Number of lectures = 08	Title of the unit: Implementation of six sigma	Mapped CO: 5

Steps in implementation of six sigma, selection of six sigma projects, sustenance of six sigma communication plan, company culture, reinforcement and control.

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	2	2	2	1	1	2	1	1				
CO2	3	3	1	2	1	2	3	2	3	1	1				
CO3	3	3	3	3	1	1	1		1	2	2				
CO4	3	3	3	3	1	1	1		1	2	1				
CO5	3	2	1	1	1	3	3	3	3	3	3				

3 Strong contribution, 2 Average contribution , 1 Low contribution

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

13. Books recommended:

1. Six Sigma, SPC and TQM in manufacturing and service: Geoff Tennant Gower
2. Six Sigma for managers: Greg Brue, TMH
3. What is Six Sigma: Peter S Pande, TMH
4. The Six Sigma way: Peter S Pande, TMH
5. Introduction to Six Sigma- Methods, Approach and Application – N A Siddiqui & Abhishek Dwivedi