COURSE STRUCTURE

for

B.TECH. DEGREE

in

COMPUTER SCIENCE & DESIGN

(Applicable from the academic session 2024-2025)

DR. B.C. ROY SOCIETY
ENGINEERING
AN AUTONOMOUS INSTITUTE

Dr. B. C. Roy Engineering College

An Autonomous Institution

Approved by: All India Council for Technical Education (AICTE)

Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal (Formerly Known as -WBUT)

Jemua Road, Durgapur, West Bengal, India,713206

The first year course structure (Page 3 and Page 4) is unanimously accepted and approved in the first BoS meeting held in the Department of a) Physics, b) Chemistry, c) Mathematics, d) English, e) Electrical Engineering, f) Electronics and Communication Engineering, g) Computer Science and Engineering, h) Mechanical Engineering.

The BoS of CSD (Computer Science & Design) in its first meeting (held in the Department of CSD (Computer Science & Design) on 6th November 2024 has unanimously accepted and approved the four year course structure of CSD (Computer Science & Design).

HOD
Computer Sc. & Design
Dr. B. C. Roy Engineering College
Durgapur

Dr. B. C. Roy Engineering College, Durgapur
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Syllabus for B. Tech in Computer Science & Design

Semester: VI					
Sl. No.	**Course Type**	**Course Code**	**Course Title**	**Engagement Type**	**Credit**
1	PC	CSD-601	Software Engineering	T	3
2	PC	CSD-602	Artificial Intelligence and Machine Learning	T	3
3	PC	CSD-603	Internet of Things	T	3
4	PC	CSD-604	Aesthetics & Arts	T	3
5	PE	CSD-611	Wearable Devices, Interactions and Applications	T	3
		CSD-612	Human Computer Interaction		
		CSD-613	Robotics		
6	OE	CSD-621	Compiler Design	T	3
		CSD-622	Embedded System		
		CSD-623	Computer Vision		
		CSD-624	Wireless Sensor Networks		
7	PC	CSD-692	Artificial Intelligence and Machine Learning Lab	P	2
8	PC	CSD-693	Internet of Things Lab	P	2
9	PC	CSD-694	Data Visualization Workshop	P	2
TOTAL CREDIT					**24**

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Syllabus for B. Tech in Computer Science & Design

Semester-VI			
Subject/Course Name	Software Engineering	**Subject/Course Code**	CSD-601
Contact Lecture/Week	3	**Tutorial**	1
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	The aim of the course is to provide an understanding of the working knowledge of the techniques for estimation, design, testing and quality management of large software development projects.
2	Topics include process models, software requirements, software design, software testing, software process/product metrics, risk management, quality management and UML diagrams
3	

Prerequisite	
1	

Unit	Content	Hours/Unit
1	Overview of System Analysis & Design , Business System Concept, System Development Life Cycle, Waterfall Model , Spiral Model, Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model. **[10L]**	10
2	System Design – Context diagram and DFD ,Problem Partitioning, Top Down And Bottom-Up design; Decision tree, Decision table and structured English ;Functional vs. Object- Oriented approach.**[5L]**	5
3	Coding & Documentation – Structured Programming, Object Oriented Programming, Information Hiding, Reuse, System Documentation.**[4L]** Testing – Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation &Verification Metrics, Monitoring & Control.**[8L]**	10
4	Software Project Management –Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring.**[7L]**	5
5	Static and dynamic models, why modeling, UML diagrams: Class diagram, interaction diagram: collaboration diagram, sequence diagram, stat chart diagram, activity diagram, implementation diagram. **[10 L]**	10

Textbook and Reference Books	
1	Pressman, Software Engineering: A practitioner's approach–(TMH)
2	Pankaj Jalote, Software Engineering-(Wiley-India)

3	N.S.Gill, Software Engineering– (Khanna Publishing House)
4	Rajib Mall, Software Engineering-(PHI)
5	Agarwal and Agarwal, Software Engineering–(PHI)
6	Sommerville, Software Engineering–Pearson
7	MartinL .Shooman, Software Engineering–TMH
8	

Course Outcome: On completion of the course students will be able to

CSD-601.1	Define / Explain the fundamental concepts / terms of Software Engineering and its necessity / importance.
CSD-601.2	Apply the basic principles to solve simple model problems related to Software Engineering in the real world.
CSD-601.3	Analyze a given Software Engineering problem, design and implement a solution, and compute the output.
CSD-601.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Software Engineering problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-601.5	Identify unsolved real world Software Engineering problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

Dr. B. C. Roy Engineering College, Durgapur
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Syllabus for B. Tech in Computer Science & Design

Semester-VI			
Subject/Course Name	Artificial Intelligence & Machine Learning	**Subject/Course Code**	CSD-602
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	To learn the concept of how to learn patterns and concepts from data without being explicitly programmed.
2	To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3	Explore supervised and unsupervised learning paradigms of machine learning.
4	To explore Deep learning technique and various feature extraction strategies.
5	

Prerequisite	
1	

Unit	**Content**	**Hours/Unit**
1	Introduction [1] Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem. Intelligent Agents [2] Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents. Problem Solving [2] Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, and issues in the design of search programs.	5
2	Search techniques [5] Solving problems by searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies.	5

3	Supervised Learning (Regression/Classification) • Basic methods: Distance-based methods, Nearest Neighbours, Decision Trees, Naive Bayes • Linear models: Linear Regression, Logistic Regression, Generalized Linear Models • Support Vector Machines, Nonlinearity and Kernel Methods • Beyond Binary Classification: Multi-class/Structured Outputs, Ranking	8
4	Unsupervised Learning • Clustering: K-means/Kernel K-means • Dimensionality Reduction: PCA and kernel PCA • Matrix Factorization and Matrix Completion • Generative Models (mixture models and latent factor models) Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)	8
5	Introduction to Deep Learning and Feature Representation Learning, Reinforcement Learning, Introduction to Bayesian Learning and Inference, Recent trends in various learning techniques of machine learning and classification methods	6
6	Introduction to NLP, Regular Expressions Basic Regular Expression Patterns, Counting Words - Unsmoothed N-grams .Smoothing- Back-off Deleted Interpolation – Entropy - English Word Classes - Tag sets for English Part of Speech Tagging-Rule Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation-Based Tagging	4

Textbook and Reference Books

1	Parallel Programming, Barry Wilkinson, Michael Allen, Pearson Education, 2nd Edition.
2	Introduction to Parallel algorithms by Jaja from Pearson, 1992
3	Akmajian, A., R. A. Demers, A. K. Farmer, and R. M. Harnish (2010). Linguistics: An introduction to language and communication (Sixth ed.). Cambridge, MA: MIT press.
4	Arora, S. and B. Barak (2009). Computational complexity: a modern approach. Cambridge University Press

Course Outcome : On completion of the course students will be able to

CSD-602.1	Define / Explain the fundamental concepts / terms of Artificial Intelligence & Machine Learning and its necessity / importance.
CSD-602.2	Apply the basic principles to solve simple model problems related to Artificial Intelligence & Machine Learning in the real world.
CSD-602.3	Analyze a given Artificial Intelligence & Machine Learning problem, design and implement a solution, and compute the output.
CSD-602.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of an Artificial Intelligence & Machine Learning problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.

CSD-602.5	Identify unsolved real world Artificial Intelligence & Machine Learning problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Internet of Things	**Subject/Course Code**	CSD-603
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	Able to understand the application areas of IOT
2	Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
3	Able to understand building blocks of Internet of Things and characteristics
4	

Prerequisite	
1	

Unit	Content	Hours/Unit
1	Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT	6
2	Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	6
3	Important Characteristics of Sensors: Determination of the Characteristics Fractional order element: Constant Phase Impedance for sensing applications such as humidity, water quality, milk quality Impedance Spectroscopy: Equivalent circuit of Sensors and Modelling of Sensors Importance and Adoption of Smart Sensors	8
4	Architecture of Smart Sensors: Important components, their features Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel	8
5	Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor, Usefulness of Silicon Technology in Smart Sensor And Future scope of research in smart sensor	5
6	Recent trends in smart sensor for day to day life, evolving sensors and their architecture.	3

Textbook and Reference Books	
1	Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing
2	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing
3	Jeeva Jose, Internet of Things, Khanna Publishing House.
4	Internet of Things, Arsheep Bahga and Vijay Madi setti
5	

Course Outcome : On completion of the course students will be able to	
CSD-603.1	Define / Explain the fundamental concepts / terms of Internet of Things and its necessity / importance.
CSD-603.2	Apply the basic principles to solve simple model problems related to Internet of Things in the real world.
CSD-603.3	Analyze a given Internet of Things problem, design and implement a solution, and compute the output.
CSD-603.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Internet of Things problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-603.5	Identify unsolved real world Internet of Things problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester VI			
Subject/Course Name	Aesthetics and Art	**Subject/Course Code**	CSD-604
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective

1	What is the nature of mind/consciousness - is it immaterial or material, or both? How do we understand the relation between the mind, brain and the body on the one hand, and the mind and the external world,on the other? What is it to have a mental representation or a 'thought'? Are such mental representations,intentional states, and 'experiencing' itself (such as experiencing pain) inseparable from self - consciousness, such that without self-consciousness there can be no consciousness? Can 'thinking' be processively or functionally reproduced in computers? Is the possibility of such reproduction essential to fully grasping what the mind is? These are some of the issues that this course will investigate, by first situating them within the broader epistemological and ontological debates in which they arose, before turning to more contemporary approaches and theoretical responses.

Prerequisite

1	

Unit	Content	Hours/Unit
1	Introduction: Descartes and Mind-Body dualism, Kant: Copernican turn; The 'I think' argument , The link between Consciousness, self-consciousness and the 'Transcendental I' , Hume: Empiricism, Skepticism and the argument against a permanent self,	10
2	Ryle: The Concept of Mind, 'Descartes Myth', Crane: The Mechanical Mind, Intro and 'The Puzzle of Representation', Nagel, "What is it Like to be a Bat",	12
3	Turing: Computing Machinery and Intelligence , Crane: The Mechanical Mind,'Computers and Thoughts', Crane: 'Computers and Thoughts' continued,	10
4	Searle:“Minds, Brains, and Programs",Chinese Room Analogy, Dennett: “CanMachines Think?”	8

Textbook and Reference Books

1	Rene Descartes, Meditations on First Philosophy
2	Immanuel Kant, Critique of Pure Reason

3	David Hume, A Treatise of Human Nature
4	Gilbert Ryle, The Concept of Mind
5	Tim Crane, The Mechanical Mind
6	David Chalmers (ed), Philosophy of Mind: Classical and Contemporary Readings
7	A. M. Turing , "Computing Machinery and Intelligence", in Mind, Vol. LIX, Issue 26
8	J. Searle, Minds, Brains, and Programs.”in Behavioral and Brain Sciences, Vol. 3 Issue 3

Course Outcome: On completion of the course students will be able to

CSD-604.1	Define / Explain the fundamental concepts / terms of Aesthetics and Art and its necessity / importance.
CSD-604.2	Apply the basic principles to solve simple model problems related to Aesthetics and Art in the real world.
CSD-604.3	Analyze a given Aesthetics and Art problem, design and implement a solution, and compute the output.
CSD-604.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of an Aesthetics and Art problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-604.5	Identify unsolved real world Aesthetics and Art problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Wearable Devices, Interactions and Applications	**Subject/Course Code**	CSD-611
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	This is a course about the current paradigm of Wearable Computing. This course will cover the origins, pioneering contributions, and principles of Wearable Computing. With this foundation, it will initiate the exploration into the space by learning how to design physical device, digital (applications) as well as human (interaction techniques) aspects of wearable. It will help to develop the skills needed to conduct design of these three interrelated elements and also get a chance to apply them
2	

Prerequisite	
1	

Unit	**Content**	**Hours/Unit**
1	Introduction to Wearable Computing; Course overview, looking inside technology, Applications of Wearable Technology,	6
2	Manual Prototyping, Emerging opportunities for wearable's; Wearable Prototyping, Designing for wear ability, Arduino Prototyping, Challenges of Wearable Computing	10
3	Intelligent agents: Sensing, Activity Recognition, Thresholding based event detection, Intelligent agents II: Just-in-time Information Retrieval, Context awareness, Capture and Access, Context-aware prototyping	12
4	Input techniques, Soft-good prototyping, Output: Audio, visual, tactile, Privacy and Social Acceptability.	10

Textbook and Reference Books	
1	Krumm, J. (2010).Ubiquitous computing fundamentals. Boca Raton: Chapman & Hall/CRC Press.
2	

Course Outcome: On completion of the course students will be able to	
CSD-611.1	Define / Explain the fundamental concepts / terms of Wearable Devices, Interactions and Applications and its necessity / importance.

CSD-611.2	Apply the basic principles to solve simple model problems related to Wearable Devices, Interactions and Applications in the real world.
CSD-611.3	Analyze a given Wearable Devices, Interactions and Applications problem, design and implement a solution, and compute the output.
CSD-611.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Wearable Devices, Interactions and Applications problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-611.5	Identify unsolved real world Wearable Devices, Interactions and Applications problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Human Computer Interaction	**Subject/Course Code**	CSD-612
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective

1	Learn the foundations of Human Computer Interaction
2	Be familiar with the design technologies for individuals and persons with disabilities
3	Be aware of mobile Human Computer interaction
4	Learn the guidelines for user interface.
5	

Prerequisite

1	Digital Electronics, Computer Organization &Architecture
2	

Unit	Content	Hours/Unit
1	Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.	9
2	Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle usability engineering – Prototyping in practice – design rationale. Design rules, principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.	11
3	Cognitive models –Socio-Organizational issues and stake holder requirements– Communication and collaboration models-Hypertext, Multimedia and WWW.	8
4	Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	8
5	Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.	8
6	Recent Trends: Speech Recognition and Translation, Multimodal System	3

Textbook and Reference Books

1	Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2	Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley
3	

Course Outcome: On completion of the course students will be able to

CSD-612.1	Define / Explain the fundamental concepts / terms of Human Computer Interaction and its necessity / importance.
CSD-612.2	Apply the basic principles to solve simple model problems related to Human Computer Interaction in the real world.
CSD-612.3	Analyze a given Human Computer Interaction problem, design and implement a solution, and compute the output.
CSD-612.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Human Computer Interaction problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-612.5	Identify unsolved real world Human Computer Interaction problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Robotics	**Subject/Course Code**	CSD-613
Contact Lecture/Week	3	**Tutorial**	Nil
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	
2	
3	

Prerequisite	
1	
2	
3	

Unit	Content	Hours/Unit
1	**Module 1: Introduction to robotics** Brief History, Definition, Robot Anatomy, Three laws, Classification of robots, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response etc., Wrist assembly, Joint notations, Selection criteria of any robot, Industrial applications of robot, Futuristic robotics.	5
2	**Module 2: Robot drive systems, End effectors and Automation** Types of drives – Hydraulic, Pneumatic and Electric, Comparison of all such drives, DC servo motors, Stepper motors, AC servo motor – salient features and applications, pulse count calculations End effectors - Types of Grippers – Mechanical, Magnetic, vacuum, pneumatic and hydraulic, selection and design considerations,	7
3	**Module 3: Robot sensors and Machine Vision** Need for sensors, types of sensors used in Robotics, classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Robot Vision setup (RVS), block diagram, components, working of RVS, Human vision Vs Robot Vision, Gradient calculations, Applications of RVS	3

4	**Module 4: Mathematical Preliminaries of Robotics** Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, Homogeneous transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, and Euler Parameters.	8
5	**Module 5: Robot Kinematics** Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Forward Kinematics, Inverse Kinematics	7

Textbook and Reference Books

1	Robotics Process Automation, Khanna Publishing House
2	Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014
3	Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
4	

Course Outcome: On completion of the course students will be able to

CSD-613.1	Define / Explain the fundamental concepts / terms of Robotics and its necessity / importance.
CSD-613.2	Apply the basic principles to solve simple model problems related to Robotics in the real world.
CSD-613.3	Analyze a given Robotics problem, design and implement a solution, and compute the output.
CSD-613.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Robotics problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-613.5	Identify unsolved real world Robotics problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Compiler Design	**Subject/Course Code**	CSD-621
Contact Lecture/Week	3	**Tutorial**	1
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	To understand and list the different stages in the process of compilation.
2	Identify different methods of lexical analysis
3	Design top-down and bottom-up parsers
4	Identify synthesized and inherited attributes
5	Develop syntax directed translation schemes
6	Develop algorithms to generate code for a target machine

Prerequisite	
1	Knowledge of Formal Language of Automata Theory
2	

Unit	Content	Hours/Unit
1	**Introduction to Compiling** [3L] Compilers, Analysis of the source program, The phases of the compiler, Cousins of the compiler.	3
2	**Lexical Analysis** [6L] The role of the lexical analyzer, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of tokens, Finite automata, From a regular expression to an NFA, From a regular expression to NFA, From a regular expression to DFA, Design of a lexical analyzer generator (Lex).	6
3	**Syntax Analysis**[9L] The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR,LALR), Parser generators (YACC). Error Recovery strategies for different parsing techniques.	9
4	**Syntax directed translation** [5L] Syntax director definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L attributed definitions, Bottom-up evaluation of inherited attributes.	5

5	**Type checking**[4L] Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions	4
6	**Run time environments**[5L] Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques.	5
7	**Intermediate code generation** [4L] Intermediate languages, Graphical representation, Three address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	4
8	**Code optimization**[5L] Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic blocks, The Principle sources of optimization, Loop sin flow graph, Peephole optimization.	5
9	**Code generations** [4L] Issues in the design of code generator, a simple code generator, Register allocation & assignment.	4

Textbook and Reference Books

1	Aho, Sethi, Ullman -"Compiler Principles, Techniques and Tools"- Pearson Education.
2	Holub- "Compiler Design in C"-PHI.
3	

Course Outcome : On completion of the course students will be able to

CSD-621.1	Define / Explain the fundamental concepts / terms of Compiler Design and its necessity / importance.
CSD-621.2	Apply the basic principles to solve simple model problems related to Compiler Design in the real world.
CSD-621.3	Analyze a given Compiler Design problem, design and implement a solution, and compute the output.
CSD-621.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Compiler Design problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-621.5	Identify unsolved real world Compiler Design problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Embedded System	**Subject/Course Code**	CSD-622
Contact Lecture/Week	3	**Tutorial**	1
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is designed for a specific function or for specific functions within a larger system. Industrial machines, agricultural and process industry devices, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys as well as mobile devices are all possible locations for an embedded system.

Prerequisite	
1	Basic Knowledge of Microprocessor & Microcontroller
2	Basic knowledge of programming

Unit	**Content**	**Hours/Unit**
1	Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML	6
2	Introduction to ARM-v7-M (Cortex-M3), ARM-v7-R (CortexR4) and comparison in between them	6
3	Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	9

4	Embedded C-programming concepts (from embedded system point of view): Optimizing forSpeed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multithreading programming. (Laboratory work on J2ME Java mobile application). Basic embedded C programs/applications for ARM-v7, using ARM-GCC- tool chain, Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board CASE STUDY: 1) Medical monitoring systems, 2) Process control system (temp, pressure) 3) Soft real time: Automated vending machines, 4) Communication: Wireless (sensor) networks.	8
5	Real time operating system: POSIX Compliance, Need of RTOS in Embedded system software, Foreground/Background systems, multitasking, context switching, IPC, Scheduler policies, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS. Introduction to µCOS-II RTOS, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management in µCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II.	8

Textbook and Reference Books

1	Introduction to Embedded Systems: Shibu K. V. (TMH)
2	Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
3	Embedded Systems: Rajkamal (TMH)
4	Embedded Systems: L. B. Das (Pearson)
5	Embedded System design: S. Heath (Elsevier)
6	Embedded microcontroller and processor design: G. Osborn (Pearson)
7	Embedded Systems: Frank Vahid, Wiley India, 2002
8	Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage

Course Outcome: On completion of the course students will be able to

CSD-622.1	Define / Explain the fundamental concepts / terms of Embedded System and its necessity / importance.
CSD-622.2	Apply the basic principles to solve simple model problems related to Embedded System in the real world.
CSD-622.3	Analyze a given Embedded System problem, design and implement a solution, and compute the output.
CSD-622.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of an Embedded System problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-622.5	Identify unsolved real world Embedded System problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Computer Vision	**Subject/Course Code**	CSD-623
Contact Lecture/Week	3	**Tutorial**	1
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	The goal is to develop understanding of the fundamental concepts in computer vision and enable students to understand and develop applications using existing tools. Students will be given theoretical and programming assignments targeted towards solving real-world computer vision problems.
2	

Prerequisite	
1	Linear Algebra, Image Analysis, Digital Signal Processing
2	

Unit	Content	Hours/Unit
1	Introduction to Computer Vision, Camera geometry and camera calibration, Camera geometry and camera calibration Review of Digital Image Processing	8
2	Edge Detection and Hough Transforms, Image Segmentation, Feature Point Detection- Harris, SIFT, HOG, LBP, STIP, Feature Detection and Description - Bag of Words, VLAD, Object Recognition – SVMs, Detection - Viola Jones Object detector	10
3	Convolutional Neural Networks and Applications Convolution Neural Networks and Applications, Optical Flow/ Overflow, KLT based object tracking	8
4	Projective Geometry - Basics and 2D transformations (Euclidean, Similarity, Affine and Projective), Epipolar Geometry - Fundamental and Essential Matrix, Least Squares and Robust Estimation (RANSAC), Stereo reconstruction, SfM and Bundle Adjustment, Homography and panorama creation., Recent Progress in Computer Vision, Review and Overflow.	10

Textbook and Reference Books	
1	Richard Szeliski's draft "Computer Vision: Algorithms and Applications"
2	Richard Hartley and Andrew Zisserman, \Multiple View Geometry", Cambridge University Press, 2004
3	David Forsyth, Jean Ponce, \Computer Vision: A Modern Approach", Pearson Education, second edition.

4	Simon J. D. Prince, \Computer Vision: Models, Learning, and Inference", 1st Edition, Cambridge University Press, 2012

Course Outcome : On completion of the course students will be able to

CSD-623.1	Define / Explain the fundamental concepts / terms of Computer Vision and its necessity / importance.
CSD-623.2	Apply the basic principles to solve simple model problems related to Computer Vision in the real world.
CSD-623.3	Analyze a given Computer Vision problem, design and implement a solution, and compute the output.
CSD-623.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Computer Vision problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-623.5	Identify unsolved real world Computer Vision problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI			
Subject/Course Name	Wireless Sensor Networks	**Subject/Course Code**	CSD-624
Contact Lecture/Week	3	**Tutorial**	1
Credit	3	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective

1	Provide an overview about sensor networks and emerging technologies.
2	To study about the node and network architecture of sensor nodes and its execution environment.
3	To understand the concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN.
4	To learn about topology control and clustering in networks with timing synchronization for localization services with sensor tasking and control.
5	To study about sensor node hardware and software platforms and understand the simulation and programming techniques.
6	

Prerequisite

1	

Unit	Content	Hours/Unit
1	Introduction and Overview: Overview of wireless networks, types, infrastructure based and infrastructure-less, introduction to MANETs (Mobile Ad-hoc Networks), characteristics, reactive and proactive routing protocols with examples, introduction to sensor networks, commonalities and differences with MANETs constraints and challenges, advantages, applications, enabling technologies for WSNs.	4
2	Architectures Single-node architecture - hardware components, design constraints, energy consumption of sensor nodes , operating systems And execution environments, examples of sensor nodes sensor network scenarios, types of sources and sinks – single hop vs. multi hop networks, multiple sources and sinks – mobility, optimization goals and figures of merit, gateway concepts, design principles.	9

3	Communication Protocols: Physical layer and transceiver design considerations, MAC protocols for wireless sensor networks, low duty cycle protocols and wakeup concepts - S-MAC , the mediation device protocol, wakeup radio concepts, address and name management, assignment of MAC addresses, routing protocols classification, gossiping, flooding, energy efficient routing, unicast protocols, multipath routing, data-centric routing, data aggregation, SPIN, LEACH, Directed Diffusion, geographic routing.	9
4	Infrastructure Establishment: Topology control, flat network topologies, hierarchical networks by clustering, time synchronization, properties, protocols based on sender-receiver and receiver-receiver synchronization, LTS, TPSN, RBS, HRTS, localization and positioning, properties and approaches, single-hop localization, positioning in multi-hop environment, range based localization algorithms – location services, sensor tasking and control	8
5	Sensor Network Platforms and Tools: Sensor node hardware, Berkeley motes, programming challenges, node level software platforms, node-level simulators, state-centric programming, Tiny OS, nesC components, NS2 simulator, TOSSIM.	6

Textbook and Reference Books

1	Holger Karl & Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
2	Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3	Kazem Sohraby, Daniel Minoli, &Taieb Znati, “Wireless Sensor Networks- Technology, Protocols, and Applications”, John Wiley, 2007.
4	Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.
5	Thomas Haenselmann, "Sensor Networks", available online for free, 2008.

Course Outcome : On completion of the course students will be able to

CSD-624.1	Define / Explain the fundamental concepts / terms of Wireless Sensor Networks and its necessity / importance.
CSD-624.2	Apply the basic principles to solve simple model problems related to Wireless Sensor Networks in the real world.
CSD-624.3	Analyze a given Wireless Sensor Networks problem, design and implement a solution, and compute the output.
CSD-624.4	Identify sub-tasks / sub-systems , Perform Diagnostic assessment of a Wireless Sensor Networks problem, integrate / interconnect these sub-tasks to design an integrated working solution and Evaluate the solution.
CSD-624.5	Identify unsolved real world Wireless Sensor Networks problems, Synthesize pragmatic ideas and Create innovative solutions to such problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI (PRACTICAL)			
Subject/Course Name	AI & ML Lab	**Subject/Course Code**	CSD-692
Contact Practical/Week	4	**Tutorial**	Nil
Credit	2	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60
Objective			
1			
Prerequisite			
1			

Sl No	Content
1	WAP in Python to simulate the rolling DICE and calculate MEAN and Standard Deviation (SD).
2	WAP in Python to read DATA from a file and check the distribution of the DATA through Histogram.
3	WAP in Python to estimate the Mean, SD and Confidence on the estimation about the quality of the DATA in experiment
4	WAP in Python to estimate the Mean Standard Error (MSE) and Coefficient of Determination (R) from a set of experimental DATA of your choice.
5	Implement Logistic Regression.
6	Implement K-means Clustering to Find Natural Patterns in Data
7	Implement Hierarchical clustering
8	Implement K-mode clustering
9	Implement k-nearest neighbour algorithms
10	Implement classification based on association rules
11	Implement Gaussian Mixture Model Using the Ex excitation Maximization

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI (PRACTICAL)			
Subject/Course Name	IoT Lab	**Subject/Course Code**	CSD-693
Contact Practical/Week	4	**Tutorial**	Nil
Credit	2	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective

1	To familiarize with different types of sensors/actuators and development board used in Internet of Things applications
2	To learn device level programming using C and Python
3	To implement Internet of Things protocols

Prerequisite

1	Basic knowledge of Linux commands, C/Java, Python, Database and Computer Networks

Sl No	Content
1	Study and configure the development board
2	Write a program to establish database connectivity using Python and perform basic query operations
3	Write a program to implement client-server interaction
4	Study the working of different types of sensors using IoT Training Kit
5	Write a program to prepare a humidity data logger and access the logs over Wifi /Ethernet
6	Write a program to collect temperature data and turn on/off actuator like servo motor, led etc based on some fixed threshold value of the temperature. The collected temperature data should be stored in the database and displayed to the user upon request.
7	Write a program to display a warning message if fire is detected using flame sensor
8	Write a program to control lights using motion sensor
9	Write a program to access, capture and store the image feed from serial camera
10	Study and Implement MQTT Protocol
11	Study the functionalities and working of drones
12	Write a program to collect sensor data using drone and send the data to the users using MQTT protocol
13	Study the functionalities and working of a mobile robot

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**

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Semester-VI (PRACTICAL)			
Subject/Course Name	Data Visualization Workshop	**Subject/Course Code**	CSD-694
Contact Practical/Week	4	**Tutorial**	Nil
Credit	2	**Maximum Marks**	100
Examination Scheme			
Internal Exam (CIA)	40	**Final Exam (ESE)**	60

Objective	
1	Learn the foundations of visual perception
2	Be familiar with the data analysis and visual design techniques
3	Learn to apply visualization principles for data analysis and applications
Outcome	
1	Explain principles of visual perception.
2	Apply core skills for visual analysis.
3	Apply visualization techniques for various data analysis tasks.
4	Design interactive and animated visualization.
Prerequisite	
1	Basic Mathematics, Programming, Python

Sl No	**Content**
1	**Introduction to Data Visualization** Evolution of Data Visualizing, its Need, Info graphics Vs Data Visualization, Gestalt's theory of visual perception, Advantage and Benefits of Data Visualization, Digital data and its classification.
2	Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data (Building a table, Using Semantic Table, Configuring the columns), Good chart Design.
3	**Data Handling in Python** Pandas Data manipulation – Pandas, Series, Dealing with missing values, Reshaping, filtering, merging, Data Frames, Pivot Tables. Pandas Functions – Group by, Correlations Data Frame methods and Properties.

4	**Visualizing data using Matplotlib** Matplotlib'spyplot API, Box plot, Relating data table to a chart, Pie chart, Scatter plot, Histogram, line plot, Bar plot, Interactive features of Matplotlib.
5	**Data Visualization with Seaborn** Seaborn plots using "iris" dataset, Swarm plot, count plot, Violin Plot, Pair Plot, Implot plot, DistPlot.
6	**Making charts interactive and animated:** Data joins, updates and exits, interactive buttons, Updating charts, Adding transactions, using keys.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	1	1	2	1	3
CO2	3	3	3	3	3	2	2	1	1	2	1	3
CO3	3	3	3	3	3	2	2	1	1	2	1	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3
CO5	3	3	3	3	3	2	2	1	1	2	1	3
Average	3	3	3	3	3	2	2	1	1	2	1	3

	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**
CO2	**3**	**3**	**3**
CO3	**3**	**3**	**3**
CO4	**3**	**3**	**3**
CO5	**3**	**3**	**3**