PAAVAI ENGINEERING COLLEGE (Autonomous)

B.E. - ROBOTICS AND AUTOMATION

REGULATIONS – 2019 (CBCS)

CURRICULUM

SEMESTER VII

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	RA20701	AI for Robotics	3	0	0	3
2	PC	RA20702	Mobile Robotics	3	0	0	3
3	PC	RA20703	Vision Systems	3	0	0	3
4	PE	RA2035*	Professional Elective - III*	3	0	0	3
5	PE	RA2045*	Professional Elective - IV*	3	0	0	3
6	OE	RA20903	Open Elective - II*	3	0	0	3
Practical							
7	PC	RA20704	Automation and Sensor Systems Laboratory		0	2	1
8	PC	RA20705	Robotics Laboratory	0	0	2	1
9	EE	RA20706	Project Work (Phase I)	0	0	6	3
Total				**18**	**0**	**10**	**23**

PROFESSIONAL ELECTIVE COURSES (PE)

PROFESSIONAL ELECTIVE - III

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	IT20***	Internet Tools and Java Programming	3	0	0	3
2	PE	RA20351	Computer Integrated Manufacturing	3	0	0	3
3	PE	RA20352	Medical Robotics	3	0	0	3
4	PE	RA20353	Optimization Techniques	3	0	0	3

PROFESSIONAL ELECTIVE - IV

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	IT20***	Big Data Analytics	3	0	0	3
2	PE	BA23152	Total Quality Management	3	0	0	3
3	PE	RA20451	Drone Technologies	3	0	0	3
4	PE	RA20452	Electronics Manufacturing Technology	3	0	0	3

OPEN ELECTIVE COURSES (OE)

OPEN ELECTIVE – II

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	RA20903	Foundation of Robotics	3	0	0	3
2	OE	RA20904	Micro robotics	3	0	0	3

RA20701	AI FOR ROBOTICS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	study the concepts of Artificial Intelligence.				
2	learn the methods of solving problems using Artificial Intelligence.				
3	introduce the concepts of Probabilistic reasoning and Speech recognition.				
4	understand about learning methods.				
5	understand the role of Artificial intelligence in Robotics				
UNIT I	**INTRODUCTION TO AI AND SEARCH TECHNIQUES**				**9**
Historical background of Artificial Intelligence; state space search: simple search, Depth First Search (DFS), Breadth First Search (BFS); comparison of BFS and DFS; Depth Bounded DFS; Depth First Iterative Deepening (DFID); Heuristic Search—Best First Search, Hill Climbing, local maxima; Solution Space Search; Variable Neighborhood Descent; Beam Search.					
UNIT II	**PLANNING AND REASONING**				**9**
Introduction to AI Planning—STRIPS Domain; Forward and Backward State Space Planning; Goal Stack Planning; Plan Space Planning; Uncertainty and Probabilistic Reasoning—Filtering and Prediction; Hidden Markov Models; Kalman Filters; Dynamic Bayesian Networks; Applications in AI—Speech Recognition, Decision-Making Processes.					
UNIT III	**ROBOTIC ARCHITECTURES**				**9**
Overview of the Three Paradigms: Hierarchical Paradigm—Attributes; Representative Architectures; Reactive Paradigm—Attributes; Subsumption Architecture; Potential Field Methodologies; Designing a Reactive Behavioural System; The Hybrid Deliberative/Reactive Paradigm.					
UNIT IV	**MACHINE LEARNING IN ROBOTICS**				**9**
Supervised Learning: Classification and regression using Decision Trees and k-Nearest Neighbors (k-NN); Unsupervised Learning: Clustering with k-means, Dimensionality Reduction using Principal Component Analysis (PCA); Reinforcement Learning: Basics of Markov Decision Processes and Q-learning.					
UNIT V	**NEURAL NETWORKS AND DEEP LEARNING FOR ROBOTICS**				**9**
Introduction to Neural Networks: Basic concepts, feed-forward networks, and backpropagation; Convolutional Neural Networks (CNNs): Architecture and applications in image recognition; Recurrent Neural Networks (RNNs): Concepts and basic applications in sequence prediction; Applications in Robotics: Object detection and scene understanding using deep learning.					
					TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED**
At the end of the course, the students will be able to		**(Highest Level)**
CO1	describe the types of problems that can be solved using AI methods.	Understanding (K2)
CO2	identify appropriate AI planning methods to solve a given problem.	Applying (K3)
CO3	apply basic AI algorithms for speech recognition and making decisions.	Applying (K3)
CO4	modify learning algorithms for autonomous driving tasks.	Applying (K3)
CO5	analyze appropriate AI methods to solve assembly problem	Analysing (K4)

TEXT BOOKS

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approach”, Pearson Education, India, 2019.
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”, Harlow: Addison-Wesley, 2022.

REFERENCES

1. David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010
2. Raju Bahubalendruni and Bibhuthi Bhushan Biswal, “Computer aided Optimal Robotic Assembly Sequence Generation”, Lap Lambert Academic Publishing; 1st edition, 2017.
3. Tim Jones M, “Artificial Intelligence: A Systems Approach”, Jones & Bartlett Learning; 1st edition, 2008
4. Ian Good Fellow, Yoshua Bengio & Aaron Courville, “Deep Learning”, MIT Press, USA, 2016.
5. Deepak Khemani, “A first course in Artificial Intelligence”, McGraw Hill, India,2018.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	**Programme Outcomes(POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	3	2	1	2	-	-	-	-	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	1	-	2	3	2
CO3	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO4	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO5	3	3	3	2	3	-	-	-	2	2	-	2	3	3

RA20702	MOBILE ROBOTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	introduce mobile robotic technology and its types in detail.
2	learn the kinematics of wheeled and legged robot.
3	familiarize the intelligence into the mobile robots using various sensors.
4	acquaint the localization strategies and mapping technique for mobile robot.
5	aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT I	INTRODUCTION TO MOBILE ROBOTICS	6

Introduction; locomotion of the robots; key issues on locomotion; legged mobile robots—configurations and stability; wheeled mobile robots—design space and mobility issues; unmanned aerial and underwater vehicles; teleportation and control.

UNIT II	KINEMATICS	9

Kinematic models; representation of robot; forward kinematics; wheel and robot constraints; degree of mobility and steerability; manoeuvrability; workspace; degrees of freedom; path and trajectory considerations; motion controls; holonomic robots; open loop and feedback motion control; humanoid robot—kinematics overview.

UNIT III	PERCEPTION	9

Sensors for mobile robots—classification and performance characterization; wheel/motor sensors; heading sensors; ground-based beacons; active ranging; motion/speed sensors; vision-based sensors; uncertainty; statistical representation; error propagation; feature extraction based on range data (laser, ultrasonic, vision-based ranging); visual appearance-based feature extraction.

UNIT IV	LOCALIZATION	9

Challenges in localization: sensor noise, effector noise, and aliasing; belief representation: single and multiple-hypothesis beliefs; map representation: continuous representations, decomposition strategies, and current challenges; probabilistic localization: Markov localization and Kalman filter localization; landmark and route-based localization; autonomous map building: stochastic map techniques and an introduction to Simultaneous Localization and Mapping (SLAM).

UNIT V	PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS	9

Introduction; competences for navigation: planning and reacting; path planning; obstacle avoidance; navigation architectures; modularity for code reuse and sharing; control localization; techniques for decomposition; case studies—collaborative robots; swarm robots.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	understand the appropriate mobile robots for the desired application.	Understanding (K2)
CO2	analyze the kinematics for given wheeled and legged robot.	Analysing (K4))
CO3	experiment the sensors for the intelligence of mobile robotics	Applying (K3
CO4	show the localization strategies and mapping technique for mobile robot.	Applying (K3)
CO5	catogorize the collaborative mobile robotics for planning, navigation and intelligence for desired applications.	Analysing (K4)

TEXT BOOKS

1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.

REFERENCES

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
3. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
4. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
5. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

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CO3	3	3	3	2	3	-	-	-	1	1	-	2	3	2
CO4	3	3	3	3	3	-	-	-	2	2	-	3	3	3
CO5	3	3	3	3	3	-	-	-	3	2	-	3	3	3

RA20703	VISION SYSTEMS	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	introduce the fundamentals of camera models and image formation, including pinhole and lens-based cameras				
2	provide a comprehensive understanding of image processing techniques, including filtering, transforms, multiscale analysis				
3	equip students with the knowledge of machine vision related hardware components				
4	introduce stereo vision and 3D reconstruction techniques, including epipolar geometry and surface representation, and to develop foundational skills in object				
5	familiarize students with the basics of the Robot Operating System (ROS), camera integration, ROS-Open CV interfacing using CV_bridge				
UNIT I	**INTRODUCTION TO COMPUTER VISION**	**9**			
Cameras: Pinhole cameras, cameras with lenses, sensing.Geometric Camera Models: Elements of analytical Euclidean geometry, camera parameters & perspective projection, affine cameras & affine projection.Radiometry: Light in space, light at surfaces.Image Formation: Geometry, primitives, and transformation.					
UNIT II	**SINGLE IMAGE VISION**	**9**			
Image Processing: Point operators, linear filtering, neighborhood operators, Fourier transform, pyramids and wavelets, global optimization.Feature Detection & Matching: Points & patches, edges, lines.Segmentation: Active contours, split & merge, mean shift & mode finding.					
UNIT III	**MACHINE VISION**	**9**			
Introduction to machine vision vs. computer vision; industrial cameras, lenses, and lighting; image acquisition systems (frame grabbers, industrial protocols); real-time processing and hardware constraints; object detection for inspection and measurement.					
UNIT IV	**HIGH LEVEL VISION**	**9**			
Stereo Correspondence: Epipolar geometry, sparse correspondence, dense correspondence, multi-view stereo. 3D Reconstruction: Shape from X, active range fringing, surface representation. Recognition: Object detection, face recognition, instance recognition. Introduction to deep learning in computer vision.					
UNIT V	**ROBOTIC OPERATING SYSTEM**	**9**			
Basic introduction to Robotic Operating System (ROS); installing and testing ROS camera drivers; ROS to OpenCV; the cv_bridge package; introduction to OpenCV image processing library and MATLAB programming.					
	TOTAL PERIODS:45				

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	describe geometric camera models, radiometry principles, and image formation techniques.	Understanding (K2)
CO2	apply image processing techniques such as point and neighbourhood operators, and linear filtering to analyze images.	Applying (K3)
CO3	describe the core principles of machine vision, including imaging hardware, acquisition systems, real-time processing, and object detection techniques for industrial inspection.	Understanding (K2)
CO4	infer the ability to perform stereo correspondence, 3D reconstruction, and object recognition, including face and instance recognition.	Analysing (K4)
CO5	discover foundational skills in using the Robot Operating System (ROS) with camera integration, interfacing ROS with OpenCV.	Applying (K3)

TEXT BOOKS

1. David.A. Forsyth, Jean Ponce, "Computer Vision a Modern Approach", Pearson, Upper Saddle River, 2010.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, London, 2014.

REFERENCES

1. Damian M Lyons, "Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.
2. Richard Hartley, Andrew fisherman, "Multiple view geometry in computer vision", 2012.
3. Alexander Hornberg, “Handbook of Machine Vision”, First Edition, 2006
4. Kenneth Dawson-Howe, "A Practical Introduction to Computer Vision with OpenCV", Wiley, Singapore, 2014.

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COs	Programme Outcomes(POs)											PSOs	
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CO2	3	3	2	2	2	-	-	-	1	1	-	1	3	2
CO3	3	3	3	2	3	-	-	-	2	2	-	2	3	2
CO4	3	3	3	2	3	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

IT 20360	INTERNET TOOLS AND JAVA PROGRAMMING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand key internet technologies and protocols including addressing, communication, file transfer, remote access, and messaging services.				
2	learn core java programming concepts: data types, control structures, object-oriented principles, inheritance, and abstraction.				
3	explore advanced java features such as packages, interfaces, multithreading (thread management and synchronization), gui and i/o capabilities.				
4	master java exception handling (built-in and user-defined exceptions), database connectivity using jdbc, and network communication using sockets..				
UNIT I	**INTERNET SERVICES AND PROTOCOLS**				**9**
Fundamentals; Internet addresses; File Transfer Protocol (FTP); HTTP; HTTPS; SMTP; DNS; Net Telephony; Internet Relay Chat; Newsgroups; Remote Login; Telnet; UDP; TCP.					
UNIT II	**OBJECT ORIENTED CONCEPTS**				**9**
Introduction; data types; operators; declarations; control structures; arrays and strings; input/output; Java classes—fundamentals, methods, constructors, scope rules; this keyword; object-based vs. object-oriented programming; inheritance; reusability; composing class; abstract classes; abstract functions; method overloading and method overriding; wrapper classes.					
UNIT III	**PACKAGES, INTERFACES AND MULTITHREADING**				**9**
Packages; access protection; importing packages.Interfaces: Defining and implementing interfaces, applying interfaces, variables in interfaces.Multithreaded Programming: Java thread model, priorities, synchronization, messaging, Thread class and Runnable interface, inter-thread communication.					
UNIT IV	**INPUT/OUTPUT AND USER INTERFACE**				**9**
Stream classes: byte streams, character streams, serialization.AWT-Swing Classes: Components—labels, buttons, check boxes, combo box; controls; menus; frames. Event Delegation Model: Listener and listener methods, event classes, applets.					
UNIT V	**EXCEPTION HANDLING AND DATABASE CONNECTIVITY**				**9**
Java exception types; uncaught exception; using try and catch; multiple catch clauses; nested try statements; throw; throws; Java built-in exceptions; creating user-defined exceptions.JDBC and Socket: Java Database Connectivity—driver loading, connection establishment, query execution, result set; sockets.					
					TOTAL PERIODS:45

COURSE OUTCOMES		**BT MAPPED (Highest Level)**
At the end of the course, the students will be able to		
CO1	observe the fundamental internet protocols and services, including addressing, file transfer, and communication protocols.	K2 (Understanding)
CO2	apply core Java programming concepts such as data types, control structures, and object-oriented principles.	K3 (Applying)
CO3	implement modular Java programs using packages and interfaces, and develop efficient multithreaded applications.	K3 (Applying)
CO4	experiment GUI applications using AWT and Swing, manage event handling, work with applets, and perform input/output operations using Java stream classes and serialization.	K4 (Analysing)
CO5	connect exceptions effectively, create custom exceptions, and implement database and network connectivity using JDBC and Sockets in Java	K4 (Analysing)

TEXT BOOKS

1. Patrick Naughton, Herbert Schildt, "Java 2 - The Complete Reference", McGraw Hill, New Delhi, 2015.
2. James K L, "The Internet: A Users Guide", Prentice Hall of India, New Delhi, 2003.

REFERENCES

1. Deitel and Deitel, "JAVA - How to Program", Prentice Hall International, 2013.
2. Cay S Horstmann, Gary Cornell, "Core Java", Pearson Education, 2013.
3. Walter Slavic, "Absolute Java", Pearson Education, 2013.
4. Reese G, "Database Programming with JDBC and Java", O'Reilly Publications, 2000.

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	**Programme Outcomes(POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2	2	-	-	-	1	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	1	-	1	3	2
CO3	3	3	3	3	3	-	-	-	2	2	-	2	3	2
CO4	3	3	3	2	2	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

RA20351	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3
COURSE OBJECTIVES					
To enable the students to					
1	understand the fundamental concepts of CAD/CAM, CIM, production types, automation.				
2	learn and apply various production planning and control techniques including MRP, ERP, and CAPP systems.				
3	analyze group technology, cellular manufacturing concepts, quantitative approaches in manufacturing layout design, (FMS) including AGVS, their components, benefits, and planning issues.				
4	explore the importance of communication networks, database systems, and the role of management.				
UNIT I	**INTRODUCTION**	**9**			
Concepts of CAD/CAM; CIM concepts and elements; types of production; manufacturing metrics and economics; production performance metrics; manufacturing cost—simple problems; basic elements of an automated system; advanced automation functions; levels of automation; lean production and Just-In-Time production; introduction to reverse engineering.					
UNIT II	**PRODUCTION AND COMPUTER AIDED PROCESS PLANNING**	**9**			
Production planning and control system; aggregate production planning and master production schedule; Material Requirement Planning (MRP I)—simple problems; capacity planning; shop floor control; inventory control—EOQ, WIP costs, and inventory holding costs—simple problems; introduction to Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP); process planning—manual process planning and case studies; Computer-Aided Process Planning (CAPP).					
UNIT III	**GROUP TECNOLOGY AND CELLULAR MANUFACTURING**	**9**			
Group Technology (GT); part families; parts classification and coding; simple problems in OPITZ part coding system; production flow analysis; cellular manufacturing; composite part concept; machine cell design and layout; quantitative analysis in cellular manufacturing; Rank Order Clustering Method; arranging machines in a GT cell—Hollier Method—simple problems; performance metrics in cell operation—simple problems.					
UNIT IV	**FLEXIBLE MANUFACTURING SYSTEM**	**9**			
Types of FMS and flexibility; FMS components; FMS applications and benefits; FMS planning and implementation issues; quantitative analysis of bottleneck model—simple problems in FMS; alternative approach in flexible manufacturing; Automated Guided Vehicle System (AGVS)—types of AGVS, applications, vehicle guidance technologies, vehicle management, and safety.					
UNIT V	**COMMUNICATIONS AND DATABASE MANAGEMENT**	**9**			
Information; communications matrix; computer communications; network architecture; tools and techniques; manufacturing data; database technology; database management; management of CIM—role, cost justification, expert systems.					
	TOTAL PERIODS:45				

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	understand the principles of CAD/CAM, CIM systems, and various types of production and automation levels.	K2 (Understanding)
CO2	apply production planning methods including MRP, MRP-II, ERP, and inventory models to real-world manufacturing scenarios.	K3 (Applying)
CO3	analyze Group Technology concepts, part classification, and layout planning using methods like Rank Order Clustering and Hollier's method.	K4 (Analysing)
CO4	understand the design and implementation of Flexible Manufacturing Systems and AGVS, and perform bottleneck analysis	K2 (Understanding)
CO5	organize manufacturing information systems using computer communication tools, database systems, and expert systems in CIM.	K4 (Analysing)

TEXT BOOKS

1. Mikell P Groover , "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2016.
2. Kant Vajpayee S, "Principles of Computer-Integrated Manufacturing", PHI, 2015.

REFERENCES

1. Mikell P Groover and Emory ZimmersJr , "CAD/CAM", Prentice hall of India Pvt. Ltd, 1998.
2. Rao P N , "CAD/CAM Principles and Applications", Tata McGraw Hill Publications, 2007.
3. Radhakrishnan P, Subramanyam S and Raju V , "CAD/CAM/CIM", New Age International, 2008.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	-	-	-	1	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	1	-	1	3	2
CO3	3	3	3	3	2	-	-	-	2	2	-	2	3	2
CO4	3	3	3	3	2	-	-	-	2	2	-	2	3	3
CO5	3	2	3	2	3	-	-	-	2	2	-	3	3	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
Approved
BOARD OF STUDIES
Robotics and Automation
27/06/25
AUTONOMOUS

<table>
<tr><td>RA20352</td><td colspan="3">MEDICAL ROBOTICS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="8">COURSE OBJECTIVES</td></tr>
<tr><td colspan="8">To enable the students to</td></tr>
<tr><td>1</td><td colspan="7">introduce different types of medical robots, their applications in healthcare, and localization and tracking systems used in medical robotics.</td></tr>
<tr><td>2</td><td colspan="7">understand the integration and control of surgical robots across various medical specialties.</td></tr>
<tr><td>3</td><td colspan="7">explore rehabilitation robotics, assistive devices, and their interaction with human systems</td></tr>
<tr><td>4</td><td colspan="7">study the design principles and security aspects of medical robots.</td></tr>
<tr><td>UNIT I</td><td colspan="6">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="8">ypes of medical robots; navigation; motion replication; imaging; rehabilitation and prosthetics; state-of-the-art of robotics in the field of healthcare; DICOM.</td></tr>
<tr><td>UNIT II</td><td colspan="6">LOCALIZATION AND TRACKING</td><td>9</td></tr>
<tr><td colspan="8">Position sensor requirements; tracking—mechanical linkages, optical, sound-based, electromagnetic, impedance-based; in-bore MRI tracking; video matching; fiber optic tracking systems; hybrid systems.</td></tr>
<tr><td>UNIT III</td><td colspan="6">SURGICAL ROBOTICS</td><td>9</td></tr>
<tr><td colspan="8">Minimally invasive surgery and robotic integration; surgical robotic subsystems; synergistic control; control modes; radiosurgery; orthopedic surgery; urologic surgery and robotic imaging; cardiac surgery; neurosurgery; case studies.</td></tr>
<tr><td>UNIT IV</td><td colspan="6">REHABILITATION AND ROBOTS IN MEDICAL CARE</td><td>9</td></tr>
<tr><td colspan="8">Rehabilitation for limbs; brain-machine interfaces; steerable needles; case studies.Assistive robots—types of assistive robots; case studies.</td></tr>
<tr><td>UNIT V</td><td colspan="6">DESIGN OF MEDICAL ROBOTS</td><td>9</td></tr>
<tr><td colspan="8">Design of medical robots; characterization of gestures to the design of robots; design methodologies; technological choices; security; case studies.</td></tr>
<tr><td colspan="3"></td><td colspan="5">TOTAL PERIODS:45</td></tr>
<tr><td colspan="3">COURSE OUTCOMES</td><td colspan="5" rowspan="2">BT MAPPED
(Highest Level)</td></tr>
<tr><td colspan="3">At the end of the course, the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">understand various medical robots and evaluate their roles in imaging, navigation, and prosthetics</td><td colspan="5">K2 (Understanding)</td></tr>
<tr><td>CO2</td><td colspan="2">apply sensor technologies used for localization and tracking in medical applications.</td><td colspan="5">K3 (Applying)</td></tr>
<tr><td>CO3</td><td colspan="2">describe the use of robotic systems in different surgical domains and assess control strategies.</td><td colspan="5">K2 (Understanding)</td></tr>
<tr><td>CO4</td><td colspan="2">associate assistive and rehabilitation robotic systems and interpret their case.</td><td colspan="5">K2 (Understanding)</td></tr>
<tr><td>CO5</td><td colspan="2">relate methodologies and technology choices in developing secure medical robotic systems</td><td colspan="5">K4 (Analysing)</td></tr>
</table>

TEXT BOOKS

1. Achim Schweikard, Floris Ernst , "Medical Robotics", Springer, 2015.
2. Paula Gomes , "Medical robotics Minimally invasive surgery", Woodhead, 2012.

REFERENCES

1. Jaydev P Desai, Rajni V Patel , "The Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2018.
2. Jocelyne Troccaz , "Medical Robotics", Wiley-ISTE, 2012.
3. Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
4. Farid Gharagozloo, Farzad Najam , "Robotic Surgery", 1st Edition, McGraw-Hill Education, 2008

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COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	-	-	1	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	1	-	1	3	2
CO3	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO4	3	3	3	3	2	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

RA20353	OPTIMIZATION TECHNIQUES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the basics of optimization.
2	know about constraints in optimization problems.
3	introduce the concept of nonlinear programming and learn about different nonlinear models.
4	create awareness about advanced optimization methods.
5	explore classical and nature-inspired optimization methods such as Zoutendijk's feasible direction method

UNIT I	INTRODUCTION	9

Introduction, historical development, engineering applications of optimization, statement of an optimization problem, design vector, design constraints, constraint surface, objective function, objective function surface, classification of optimization problems, classification based on: existence of constraints, design variables, physical structure of the problem, equations involved, permissible values of the design variables.

UNIT II	CLASSICAL OPTIMIZATION TECHNIQUES	9

Introduction, single-variable optimization, multivariable optimization with constraints, saddle point, multivariable optimization with equality constraints, solution by direct substitution, solution by the method of constrained variation, solution by the method of Lagrange multipliers.

UNIT III	NONLINEAR PROGRAMMING I	9

Unrestricted search, search with fixed step size, search with accelerated step size, exhaustive search, dichotomous search, interval halving method, Fibonacci method, golden section method, comparison of elimination methods. Direct Root Methods: Newton method, quasi-Newton method, secant method.

UNIT IV	NONLINEAR PROGRAMMING II	9

Random search methods, random jumping method, random walk method, random walk method with direction exploitation, advantages of random search methods, grid search method, univariate method, pattern directions, Powell's method.

UNIT V	ADVANCED METHODS	9

Zoutendijk's method of feasible directions, determination of step length, Rosen's gradient projection method, Firefly Algorithm, Artificial Bee Colony (ABC) algorithm.

TOTAL PERIODS:45

COURSE OUTCOMES At the end of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe various optimization models.	K2 (Understanding)
CO2	apply suitable techniques for constrained and unconstrained models	K3 (Applying)
CO3	formulate and solve One-Dimensional Minimization Methods.	K4 (Analysing)
CO4	experiment the problem and Solve using Unconstrained Optimization	K4 (Analysing)

	Techniques.	
CO5	apply solution to complex models.	K3 (Applying)

TEXT BOOKS

1. Singiresu S.Rao, ―Engineering Optimization: Theory and Practice, New Age International Publishers,India, 2013
2. Kalyanmoy Deb, ―Optimization for Engineering Design Algorithms and Examples, PHI Learning Private Limited, New Delhi, 2012.

REFERENCES

1. Bazara M.J., Jarvis and Sherali H., Linear Programming and Network Flows, John Wiley, 2009
2. Budnick F.S., Principles of Operations Research for Management, McGraw-Hill Inc., US, 1998
3. Philip D.T. and Ravindran A., Operations Research, John Wiley, 2007
4. Shennoy G.V. and Srivastava U.K., Operation Research for Management, New Age International Publishers; India, 2018
5. Hillier and Libeberman, Operations Research, McGraw-Hill Higher Education, New York, 2010

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
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CO4	3	3	3	3	2	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

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IT20457	BIG DATA ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the evolution, challenges, and lifecycle of big data analytics across various industry verticals
2	learn and apply core supervised and unsupervised learning algorithms in data analytics.
3	develop the ability to use Hadoop ecosystem tools for storing, processing, and analyzing large datasets, and understand stream data models with real-time analytics techniques.
4	explore NoSQL databases, graph analytics, and data visualization techniques for big data applications.

UNIT I	**BIG DATA**	**9**

Big Data overview, evolution of Big Data, definition of Big Data, challenges with Big Data; state of practice in analytics; Big Data analytics in industry verticals.Data Analytics Lifecycle: Discovery, data preparation, model planning, model building, communicating results, deployment.

UNIT II	**DATA ANALYTICS**	**9**

Theory and methods.Supervised Learning: Linear/logistic regression, decision trees, Naïve Bayes.Unsupervised Learning: K-means clustering, association rules.

UNIT III	**BIG DATA TECHNOLOGY AND TOOLS**	**9**

Hadoop; components of Hadoop; analysing data with Hadoop; HDFS. MapReduce: MapReduce programming model, developing a MapReduce application. Data processing operators in Pig; Hive services; fundamentals of HBase and ZooKeeper.

UNIT IV	**STREAM COMPUTING**	**9**

Introduction to stream concepts; stream data model and architecture; stream computing; sampling data in a stream; filtering streams; counting distinct elements in a stream; estimating moments; counting ones in a window; decaying window; real-time analytics platform (RTAP) applications.

UNIT V	**DATA MANAGEMENT AND VISUALIZATION**	**9**

NoSQL data management for Big Data; schema-less model; aggregate data models; graph analytics for Big Data; visualization techniques.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	associate the complete data analytics lifecycle from discovery to deployment for big data applications	K2 (Understanding)
CO2	analyze linear models, decision trees, clustering, and association rule-based algorithms.	K4 (Analysing)
CO3	implement scalable big data solutions using HDFS, MapReduce, Pig, Hive.	K3 (Applying)
CO4	analyze stream computing models and evaluate real-time algorithms for platforms such as RTAP	K4 (Analysing)
CO5	Correlate the NoSQL-based data models and visualization techniques.	K4 (Analysing)

TEXT BOOKS

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analysing, Visualizing and Presenting Data", John Wiley and sons, New Delhi, 2015.
2. Tom White, "Hadoop: The Definitive Guide", O`Reilly Publishers, USA, 2015.

REFERENCES

1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/Elsevier Publishers, 2013.
2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley and sons, 2012.
3. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, USA, 2014.
4. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill, 2012.

CO - PO MAPPING

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CO4	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

<table>
<tr><td>BA23152</td><td colspan="2">TOTAL QUALITY MANAGEMENT</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES</td></tr>
<tr><td colspan="7">To enable the students to</td></tr>
<tr><td>1</td><td colspan="6">know the importance of quality management, customer perception, and retention.</td></tr>
<tr><td>2</td><td colspan="6">acquaint with the principles and philosophies of quality management.</td></tr>
<tr><td>3</td><td colspan="6">understand the significance of statistical process control for quality management.</td></tr>
<tr><td>4</td><td colspan="6">interpret quality management tools and techniques</td></tr>
<tr><td>5</td><td colspan="6">relate knowledge of quality management system standards and their implementation across sectors</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO QUALITY MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="7">TQM: definitions, framework, benefits – Quality: vision, mission and policy statements- Customer Focus : customer perception of quality, translating needs into requirements- Dimensions of product and service quality, cost of quality - Service and Product quality - Foundation of TQM</td></tr>
<tr><td>UNIT II</td><td colspan="5">PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="7">Principles of Juran, Crosby, Ishikawa, Taguchi techniques: loss function, parameter and tolerance design - Quality circle - Japanese 5S principles - 8D methodology - SMART Goal Setting for Quality - Deming’s principles - PDCA Cycle</td></tr>
<tr><td>UNIT III</td><td colspan="5">STATISTICAL PROCESS CONTROL AND TQM TECHNIQUES</td><td>9</td></tr>
<tr><td colspan="7">Meaning and significance of statistical process control (SPC) – Control charts for variables and attributes - Process capability :meaning, significance and measurement – Business process re-engineering(BPR) - ERP: Role of ERP –Cause and Effect Diagram-Root Cause Analysis- New 7 QC Tools - Benchmarking</td></tr>
<tr><td>UNIT IV</td><td colspan="5">TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="7">Process capability- Quality Function Development (QFD): concepts, improvement needs and performance measures - Poka Yoke and Fool proofing Techniques - Quality Management Systems (QMS) : frameworks, documentation-Quality Auditing: Purpose and process- AI in Total Productive Maintenance</td></tr>
<tr><td>UNIT V</td><td colspan="5">QUALITY SYSTEMS AND IMPLEMENTATION</td><td>9</td></tr>
<tr><td colspan="7">ISO 9000: Need, Concepts, Documentation- Elements of ISO 9001:2015 – System Elements and Audit Process - QS 9000, ISO 14000: Requirements and Benefits - ISO Certification Process -TQM Implementation in Manufacturing and Service Sectors- Quality Assurance vs Quality Control - Quality Awards - Six sigma concepts - AI based Quality Inspection Systems</td></tr>
<tr><td colspan="3"></td><td colspan="4">TOTAL PERIODS:45</td></tr>
</table>

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	explain the purpose and importance of effective quality policies	K2 (Understanding)
CO2	describe the key quality philosophies and practices used in business	K2 (Understanding)
CO3	apply statistical process control and process capability techniques to enhance quality	K3 (Applying)
CO4	use appropriate quality tools to improve organizational quality performance	K3 (Applying)
CO5	summarize the role of quality auditing and ISO standards in quality management	K2 (Understanding)

TEXT BOOKS

TEXT BOOKS

1. Total Quality Management, by Dale H. Besterfield, 5th Edition, 2021, Pearson Education
2. Quality Management for Organizational Excellence: Introduction to Total Quality by David L. Goetsch & Stanley Davis, 9th Edition, 2021, Pearson.

REFERENCES

1. Fundamentals of Quality Control and Improvement by Amitava Mitra, 5th Edition, , 2021, Wiley
2. Total Quality Management by P.N Mukherjee 2nd Edition, 2024, PHI Learning
3. Total Quality Management: Key Concepts and Case Studies by D.R. Kiran 2nd Edition, 2020, Butterworth-Heinemann
4. Fundamentals of quality control and improvement by Mitra, *A* ,5th Edition, 2021, Wiley

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	1	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	2	1	-	2	3	2
CO3	3	3	3	3	3	-	-	-	2	1	-	2	3	3
CO4	3	3	3	3	3	-	-	-	2	1	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	3

RA20451	DRONE TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the basics of drone concepts
2	learn and understand the fundaments of design, fabrication and programming of drone
3	impart the knowledge of an flying and operation of drone
4	know about the various applications of drone
5	understand the safety risks and guidelines of fly safely

UNIT I	INTRODUCTION	9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program -Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT III	DRONE FLYING AND OPERATION	9

Concept of operation for drone -Flight modes- AI-Driven Visual Servoing and Target Tracking- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT IV	DRONE COMMERCIAL APPLICATION	9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT V	FUTURE DRONES AND SAFETY	9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license-Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL PERIODS:45

COURSE OUTCOMES At the end of the course, the students will be able to		BT MAPPED (Highest level)
CO1	Know about a various type of drone technology, drone fabrication and programming	Analysing (K4)
CO2	Execute the suitable operating procedures for functioning a drone	Understanding (K2)
CO3	Select appropriate sensors and actuators for Drones	Applying (K3)

CO4	Develop a drone mechanism for specific applications	Understanding (K2)
CO5	Create the programs for various drones	Analysing (K4)

TEXT BOOKS

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.
3. R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012
4. Terry Kilby and Belinda Kilby" Make:Getting Started with Drones" Published by Maker Media

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	**Programme Outcomes(POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1

RA20452	ELECTRONICS MANUFACTURING TECHNOLOGY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	impart knowledge on wafer preparation and PCB fabrication.
2	introduce through hole technology (THT) and surface mount technology (SMT) along with various types of electronic components.
3	elaborate the steps involved in SMT and acquaint with testing and inspection methods of populated PCBs.
4	outline repair, rework, and quality aspects of electronic assemblies.

UNIT I	**INTRODUCTION TO ELECTRONICS MANUFACTURING**	**9**

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board – fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board

UNIT II	**COMPONENTS AND PACKAGING**	**9**

Introduction to packaging, types-Through hole technology(THT) and Surface mount technology (SMT), Through hole components – axial, radial, multi leaded, odd form Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi-chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization.

UNIT III	**SURFACE MOUNT TECHNOLOGY**	**9**

SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation.

UNIT IV	**INSPECTION AND TESTING**	**9**

Inspection techniques, equipment and principle- AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

UNIT V	**REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES**	**9**

Repair and rework of PCB- Coating removal, base board repair, conductor repair, thermomechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, rework ability, testing, reliability, and environment.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	explain wafer preparation and PCB fabrication processes	K2 (Understanding)
CO2	recognize the importance of through-hole technology and surface mount technology	K2 (Understanding)
CO3	demonstrate the various steps involved in surface mount technology	K3 (Applying)
CO4	identify various testing and inspection methods used for populated PCBs	K3 (Applying)
CO5	discuss techniques related to repair, rework, quality, and reliability of electronic assemblies	K2 (Understanding)

TEXT BOOKS

1. Randal w. Beard timothy w. Mclain " Small Unmanned Aircraft" Theory and Practice, Princeton University Press Princeton and Oxford
2. R. C. Nelson, "Flight Stability and Automatic Control", McGraw Hill, New York, 1998

REFERENCES

1. L.R. Newcome, Unmanned Aviation, a Brief History of Unmanned Aerial Vehicles, American Institute of Aeronautics and Astronautics, Reston, 2004.
2. Kuo, B. C., "Automatic Control Systems", Prentice Hall, 1991
3. R. Beard, and T. W. McLain, "Small Unmanned Aircraft: Theory and Practice", Princeton University Press, 2012
4. Terry Kilby and Belinda Kilby" Make:Getting Started with Drones" Published by Maker Media

CO - PO MAPPING

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CO3	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO4	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO5	3	3	3	3	3	-	-	-	2	2	-	3	3	2

RA20903	FOUNDATION OF ROBOTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	focus on the classification of robots based on geometrical configurations (anatomy) and introduce key specifications relevant to industrial applications.
2	introduce the characteristics, selection criteria, classification, and applications of sensing devices used in robotic systems.
3	provide a comprehensive understanding of the kinematic analysis of robotic manipulators and foundational concepts of artificial intelligence (AI), including its scope, key problems, and solution approaches.
4	cover essential AI search strategies such as forward and backward search, state-space search, blind search, heuristic search, and problem reduction..

UNIT I	INTRODUCTION	9

Introduction to Robotics-classification with respect to geometrical configuration (Anatomy), Industrial robots specifications. Selection based on the Application. Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics-precession of movement resolution, accuracy & Repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response.

UNIT II	SENSORS, DRIVES AND GRIPPERS	9

Characteristics of sensing devices, Criterion for selections of sensors, Classification, & applications of sensors. Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.

UNIT III	KINEMATICS OF MANIPULATORS	9

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogeneous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots

UNIT IV	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9

Overview: foundations, scope, problems, and approaches of AI. Intelligent agents: Agent fundamentals, reactive, deliberative, goal-driven, utility-driven, and learning agents. AI Programming Techniques: Forward and backward chaining, state-space search, blind and heuristic search, problem reduction.

UNIT V	PROBLEM-SOLVING THROUGH SEARCH AND KNOWLEDGE REPRESENTATION	9

Game Playing and Problem Solving: Minimax, alpha-beta pruning, constraint propagation. Intelligent Search & Applications: Neural, stochastic, and evolutionary algorithms; sample applications. Basics of representing knowledge using concepts, relationships, and logic; introduction to ontologies, reasoning about actions, events, and time using simple examples.

	TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	differentiate between types of robots and robot grippers	K4 (Analysing)
CO2	apply basic principles of AI to solve problems involving inference, perception, knowledge representation, and learning	K3 (Applying)
CO3	understand AI, its current scope and limitations, and societal implications	K2 (Understanding)
CO4	analyse forces in links and joints of a robot	K4 (Analysing)
CO5	describe fundamental AI techniques in intelligent agents and artificial neural networks	K2 (Understanding)

TEXT BOOKS

1. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2019.
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press, 2006.

REFERENCES

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005.
2. Vinod Chandra S.S., Anand Hareendran S, "Artificial Intelligence and Machine Learning", 2014.
3. S. K. Saha, Introduction to Robotics, TATA McGraw Hills Education, 2014
4. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt. Ltd., 2012.

CO - PO MAPPING

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CO4	3	3	3	2	1	-	-	-	1	1	-	1	3	2
CO5	3	3	3	3	3	2	2	1	2	2	1	3	3	3

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RA20904	MICRO ROBOTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals, scaling effects, material properties, and applications of microsystems.
2	gain knowledge of flexure mechanisms, micro-actuators, and sensors for MEMS devices.
3	understand the definitions, fabrication technologies, mobility, functionalities, and applications of MEMS-based micro-robots, along with arrayed actuators for locomotion, micro-tools, multi-robot systems, and communication.
4	explore microfabrication principles, packaging, and micro-assembly techniques.

UNIT I	INTRODUCTION AND SCALING LAWS AND MATERIALS FOR MEMS	9

MST (Micro System Technology); micromachining; working principles of microsystems; applications of microsystems. Introduction to scaling laws; scaling effect on physical properties; scaling effects on electrical properties; scaling effect on physical forces; physics of adhesion; silicon-compatible material systems; shape memory alloys; material properties; piezoresistivity, piezoelectricity, and thermoelectricity.

UNIT II	FLEXURES, ACTUATORS AND SENSORS	9

Elemental flexures; flexure systems; mathematical formalism for flexures; electrostatic actuators; piezo-electric actuators; magnetostrictive actuators; electromagnetic sensors; optical-based displacement sensors; motion tracking with microscopes.

UNIT III	MICROROBOTICS	9

Introduction; task-specific definition of micro-robots; size- and fabrication technology-based definition of micro-robots; mobility- and functional-based definition of micro-robots; applications for MEMS-based micro-robots

UNIT IV	IMPLEMENTATION OF MICROROBOTS	9

Arrayed actuator principles for micro-robotic applications; micro-robotic actuators; design of locomotive micro-robot devices based on arrayed actuators; micro-robotic devices; micro-grippers and other micro-tools; micro-conveyors; walking MEMS micro-robots

UNIT V	MICROFABRICATION AND MICROASSEMBLY	9

Multi-robot systems: micro-robot powering, micro-robot communication. Micro-fabrication principles; design selection criteria for micromachining; packaging and integration aspects; micro-assembly platforms and manipulators.

TOTAL PERIODS:45

COURSE OUTCOMES		BT MAPPED (Highest Level)
At the end of the course, the students will be able to		
CO1	understand the concepts and applications of microsystems, micromachining, and scaling laws in MEMS	K2 (Understanding)
CO2	apply the principles of micro-actuation and sensing using flexures, electrostatic, piezoelectric, and optical techniques	K3 (Applying)
CO3	differentiate and classify micro-robots based on task, size, fabrication, and mobility	K4 (Analysing)
CO4	analyze micro-robot devices using arrayed actuators, grippers, and micro-conveyors	K4 (Analysing)
CO5	apply micro fabrication and packaging concepts for powering, communication, and integration of micro-robots	K3 (Applying)

TEXT BOOKS

1. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, New York, 2002.
2. Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2011.

REFERENCES

1. Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House, MA, 2002.
2. Julian W Gardner, "Microsensors: Principles and Applications", John Wiley & Sons, 1994.
3. Metin Sitti, "Mobile Microrobotics", MIT Press, 2017.
4. Nicolas Chaillet, Stephane Regnier, "Microrobotics for Micromanipulation", John Wiley & Sons, 2013.

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	1	1	-	1	3	2
CO2	3	3	3	2	2	-	-	-	1	1	-	1	3	3
CO3	2	3	3	2	2	1	1	-	1	1	-	2	3	3
CO4	2	2	3	3	3	1	1	-	2	1	1	2	3	3
CO5	3	3	3	2	2	-	1	-	1	1	-	2	3	2

RA20704	AUTOMATION AND SENSOR SYSTEMS LABORATORY	0	0	2	1

COURSE OBJECTIVES **To enable the students to**		
1.	understand the fundamentals of LED and light intensity control	
2.	understand about the components such as Buzzer and LCD.	
3.	understand how to work with sensors such as temperature and LDR	
4.	understand about key input and servo motor	
LIST OF THE EXPERIMENTS		
1.	Implement a program to interface a relay with Arduino.	
2.	Implement a program to interface servo motor with Arduino.	
3.	Implement a program for LCD Display using Arduino.	
4.	Implement a program for LDR using Arduino.	
5.	Implement a program for DC Motor Control using Arduino.	
6.	Implement a program for blinking LED using NODEMCU with Blynk.	
7.	Implement a program for Sensor value logging in Cloud.	
8.	Implement a program to interface stepper motor with R-Pi	
9.	Implement a program for controlling relay state based on input from IR sensors using R-Pi	
10.	Design for displaying humidity and temperature data on web based applications.	
		TOTAL PERIODS 30
COs	**COURSE OUTCOMES** At the end of this course, the students will be able to	**BT MAPPED (Highest Level)**
CO1	describe the use of any robotic simulation software to model the different types of robots and calculate work volume for different robots	K2 (Understanding)
CO2	Implement Robot programming in writing practice applications	K3 (Applying)
CO3	apply robot programming techniques for color identification tasks	K3 (Applying)
CO4	analyze industrial processes such as packaging and assembly using robotic applications	K4 (Analysing)

CO –PO MAPPING:

Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates srength of correlation)

3-Strong,2-Medium,1-Weak

COs	Programme Outcomes (POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2	2	-	-	-	1	1	-	1	3	2
CO2	2	2	3	2	3	-	-	-	1	1	-	1	2	2
CO3	3	2	3	2	3	-	-	-	1	1	-	1	3	2
CO4	3	2	3	3	3	-	1	-	1	2	-	2	3	3

RA20705	ROBOTICS LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1.	introduce the different types of robotics and demonstrate them to identify different parts and components.
2.	construct the programming for simple operations.

LIST OF THE EXPERIMENTS

1.	Determination of maximum and minimum position of links.
2.	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3.	Estimation of accuracy, repeatability and resolution.
4.	Robot programming and simulation for pick and place
5.	Robot programming and simulation for Colour identification
6.	Robot programming and simulation for Shape identification
7.	Robot programming and simulation for machining (cutting, welding)
8.	Robot programming and simulation for writing practice
9.	Robot programming and simulation for any industrial process (Packaging, Assembly)
10.	Robot programming and simulation for multi process.
	TOTAL PERIODS 30

COs	**COURSE OUTCOMES** at the end of this course, the students will be able to	**BT MAPPED (Highest Level)**
CO1	**apply** robotic simulation software to model different types of robots and **calculate** their work volume	K3 (Applying)
CO2	illustrate robot programming through writing-based practice application	K3 (Applying)
CO3	**implement** robot programming for color identification applications	K3 (Applying)
CO4	**analyze** industrial robotic applications in processes such as packaging and assembly	K4 (Analysing)

CO –PO MAPPING:														
Mapping of Course Outcomes with Programme Outcomes (3/2/1 indicates srength of correlation) 3-Strong,2-Medium,1-Weak														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2	3	-	-	-	1	1	-	2	3	2
CO2	2	2	3	2	3	-	-	-	1	1	-	2	3	2
CO3	2	2	3	2	3	-	-	-	1	1	-	2	3	2
CO4	3	2	3	2	-	-	1	-	1	2	-	2	3	3

<table>
<tr><td>RA20706</td><td colspan="2">PROJECT WORK (PHASE I)</td><td>0</td><td>0</td><td>6</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES</td></tr>
<tr><td colspan="7">To enable the students to</td></tr>
<tr><td>1</td><td colspan="6">develop ability to identify problems and solve through project works.</td></tr>
<tr><td>2</td><td colspan="6">get exposure to literature review related to identified problem and finding the gap to solve through project work.</td></tr>
<tr><td>3</td><td colspan="6">get exposure to required design procedure, experimental setup, analysis methods to solve the identified problems.</td></tr>
<tr><td>4</td><td colspan="6">prepare project reports and practice to face viva-voce examination..</td></tr>
<tr><td colspan="7">DESCRIPTION</td></tr>
<tr><td colspan="7">1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution. Identification of student group and their faculty guide need to be completed within the first two weeks from the day of the beginning of 7th semester.
3. The group has to identify and select the problem to be addressed as their project work and study literature survey to finalize a comprehensive aim and scope of their work.
4. 30% of the total work of the project work has to be completed by end of 7th semester.
5. A mini project report (of the phase-I) to this effect has to be submitted by each student group.
6. Three reviews and end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 4) along with their faculty guide as a member the review team.
7. The same team of faculty will evaluate the Project Phase - I report. This evaluation will form 50% of the internal assessment mark. The remaining 50% of the internal assessment mark will be given at the end of the 8th semester, at the time of completing the full project work.</td></tr>
<tr><td colspan="3"></td><td colspan="4">TOTAL PERIODS :90</td></tr>
</table>

COURSE OUTCOMES On completion of the project work, the students will be able to		BT MAPPED (Highest level)
CO1	identify feasible problems to solve through project works	Analyzing (K4)
CO2	collect literature through research journals and identify the gap in selected area	Analyzing (K4)
CO3	devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimization techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project	Applying (K3)
CO4	prepare project report as per format and confidently face viva voce with proper PPT for presentation	Analyzing (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO2	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO3	3	2	2	-	-	2	2	2	3	3	3	2	2	2
CO4	3	2	2	-	-	2	2	2	3	3	3	2	2	2

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