RCOEM

Shri Ramdeobaba College of
Engineering and Management, Nagpur

SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR – 440013

An Autonomous College affiliated to
Rashtrasant Tukadoji Maharaj Nagpur University,
Nagpur, Maharashtra (INDIA)

PROGRAMME SCHEME & SYLLABI
2023 – 2024

M. Tech. (Robotics & Automation)

Published By

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ISO 9001 : 2015 CERTIFIED ORGANISATION

About The Department

M. Tech in Robotics and Automation is a full time program offered by the department of Mechanical Engineering. It is the first ever program in central India, offering the state of art technology encompassing digital advancement in manufacturing and service sector. Ready to accommodate majority of the disciplines of Engineering at graduation as eligibility.

Eligibility for Admission

Min. 50% at UG level, Non-zero GATE score OR Two years' of work experience with sponsorship from the company.

B. E. / B. Tech./ AME in the following Engineering disciplines from any recognized university in India:

Mechanical, Industrial, Production, Robotics, Mechatronics, Electrical, Electronics, Computer Science, Instrumentation, Electronics and Communication and Information Technology.

Objective

The Program aims to create the technical professionals in the field of robotics and automation by inculcating strong academic foundation and hands-on exposure to recent technology as per industry needs.

Infrastructure

To achieve the objective RCOEM has established state-of-art research centre in collaboration with TATA Technologies. Centre for Invention, Innovation, Incubation & Training (CIIIT) provides comprehensive technological exposure and hands-on training to the Post-Graduate students fo Robotics and Automation.

CIIIT equipped with YASKAWA welding robot, TAL-BRABO Pick and Place Robot, Manufacturing Execution System (MES) comprised of 12 meter long conveyor automation unit and Vertical Machine Centre (VMC), 3D printer and scanner.

Many professional and commercial software like MSC ADAMS, NASTRAN, PATRON, Easy 5, Marc, Dassault Delmia, 3D Experience, FEAST from ISRO, scFLOW, Internet of Things (IoT) etc. are available to design, develop and simulate robotic and automation systems.

Career Prospects

The domain of Robotics and Automation is the most sought after by post graduate aspirants. The field of robotics and automation has an enormous range of job opportunities for the candidates.

After completing the program, students can take jobs in the field of robotics and automation such as Robotics Programmers, Robot Design Engineer, Robotics Test Engineers, Automated Product Design Engineer, Robotics System Engineer and Maintenance Engineers in manufacturing and service industry. Moreover, they can also pursue PhD.

Program Educational Objectives (PEOs)

1. To prepare the postgraduates who will search and/or create new avenues as an application of robots for industrial and societal needs.
2. Calling concern of continuous learning is a must with digital sciences. With this habit students should come out with an exalted status as a competent professional.
3. To impart adequate programming skills for robotics and languages thereby enabling them to front line research and state of art application.

Program Outcomes (POs)

1. Students will be confident to handle robotic applications independently, so as to automate entire industrial / business process.
2. Students will possess communication and interpersonal skills to ensure harmonious team working.
3. Overview of safety, awareness of economic and social impacts will be exhibited by teh students.
4. Students will be able to demonstrate the ability to take up intricate self-studies related to engineering applications.

Scheme of Examination of Master of Technology
M. Tech. (Robotics & Automation)
Semester - I

Sr. No.	Subject Code	Subject Name	L	P	Total	Credits	Internal Assess-ment	Semester Exam	Total
1	RAT701	Robot Kinematics and Dynamics	3	-	3	3	50	50	100
2	RAT702	Robotic sensors and actuators	3	-	3	3	50	50	100
3	RAT703	Mobile Robotics	3	-	3	3	50	50	100
4	RAT704	Control System theory	3		3	3	50	50	100
5	RAT705	Program Elective-1	3	-	3	3	50	50	100
6	RAP706	Robotics and IoT Lab		4	4	2	25	25	50
7	RAP707	Product Life-cycle Management Lab	-	4	4	2	25	25	50
8	RAP708	Design thinking, Innovation and Entrepreneurship		4	4	2	25	25	50
9	RAT709	Professional Practices and Ethics	1	-	1	1	50	0	50
		Total	**16**	**12**	**28**	**22**	**375**	**325**	**700**

Course Code	Program Elective-1
RAT705-1	Field and Service Robot
RAT705-2	Industrial Internet of Things (IIoT)

Scheme of Examination of Master of Technology
M. Tech. (Robotics & Automation)
Semester - II

Sr. No.	Subject Code	Subject Name	L	P	Total	Credits	Internal Assess-ment	Semester Exam	Total
1	RAT721	Advanced Industrial Automation	3	-	3	3	50	50	100
2	RAT722	Artificial Intelligence and Machine Learning in Robotics	3	-	3	3	50	50	100
3	RAT723	Research Methodology	3	-	3	3	50	50	100
4	RAT724	Program Elective -2	3	-	3	3	50	50	100
5	RAT725	PG Group Elective	3	-	3	3	50	50	100
6	RAT799	Open Elective-1	3	-	3	3	50	50	100
7	RAP726	Integrated Advance Manufacturing Lab		4	4	2	25	25	50
8	RAP727	Industrial Automation Lab	-	4	4	2	25	25	50
9	RAP728	Project Based Learning	-	4	4	2	25	25	50
		Total	**18**	**12**	**30**	**24**	**375**	**375**	**750**

Course Code	Program Elective - 2
RAT724-1	Bio-inspired Robotics
RAT724-2	Supply Chain Management

Course Code	PG Group Elective
RAT725-1	Robotic Process Automation
RAT725-2	Product life cycle Management (PLM)

Course Code	Open Elective
RAT799-1	Industrial robotics
RAT799-2	Mechatronics
RAT799-3	Electric and Hybrid Vehicle Technology

Scheme of Examination of Master of Technology
M. Tech. (Robotics & Automation)
Semester - III

Sr. No.	Subject Code	Subject Name	L	P	Total	Credits	Internal Assess-ment	Semester Exam	Total
1	RAT801	Program Elective -3	3	-	3	3	50	50	100
2	RAT802	Program Elective -4	3	-	3	3	50	50	100
3	RAP803	Dessertation Phase - I	-	3	3	6	100	100	200
		Total	**6**	**3**	**9**	**12**	**180**	**220**	**400**

OR

4	RAP804	Industry Internship-Phase-I / Research Internship-Phase-I /TBI Internship-Phase-I				**12**	200	200	400

Course Code	Program Elective - 3
RAT801-1	Smart Manufacturing and Digital Twins
RAT801-2	Economics and financial management

Course Code	Program Elective - 4
RAT802-1	Strategic Project Management
RAT802-2	Digital Manufacturing

Scheme of Examination of Master of Technology
M. Tech. (Robotics & Automation)
Semester - IV

Sr. No.	Subject Code	Subject Name	L	P	Total	Credits	Internal Assess-ment	Semester Exam	Total
1	RAP821	Dessertation Phase-II Industry Internship-Phase-II / Research Internship-Phase-II / TBI Internship-Phase-II	-	6	6	12	200	200	400

OR

1	RAP822	Industry Internship-Phase-II / Research Internship-Phase- II/TBI Internship-Phase-II				12	200	200	400

Total Credits: 22 + 24 + 12 + 12 = 70

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT701 **Course : Robot kinematics and Dynamics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

To impart knowledge about kinematic and dynamic analysis of robot manipulators.

Course Outcomes

The students will able to

CO1 : Understand the history, evolution and anatomy of robot.

CO2 : Comprehend the concept of Mapping and Transformations for kinematic of manipulator.

CO3 : Understand and apply the concept of forward and inverse kinematics of manipulator.

CO4 : Explore the computational challenges of Manipulator differential motion and Develop dynamic modeling of manipulator

CO5 : Plan the trajectory for specific task of n-DOF manipulator.

Unit - I : Introduction to robotics

Evolution of robots and robotics, Laws of robotics, Progressive advancement in robots, Robot anatomy: links, joint and joint notation scheme, degree of freedom, arm configuration, wrist configuration, End-effector and Grippers, Classification of robot, Human arm characteristics, Design and control issues, Manipulation and control, Sensors and vision, Programming robot, Future aspect.

Unit - II : Coordinate Frames, Mapping and Transformations

Coordinate frames: Mapping, Mapping between rotated frames, Mapping between translated frames, Mapping between rotated and translated frames. Description of object in space.

Transformation of vectors : Rotation of vector, translation of vector, combined rotation and translation of vectors, composite transformation, inverting a homogeneous transform.

Fundamental Rotation matrix : Principal axis rotation, fixed angle representation, Euler angle representation, Equivalent angle axis representation.

Unit - III : Direct/Forward Kinematics Modeling

Mechanical Structure and notation, Description of links and joints, Kinematic modeling of manipulator, Denavit - hartenberg notation, Kinematic relationship between adjacent links, Manipulator transformation matrix.

Inverse Kinematic Modeling

Manipulator workspace, Solvability of inverse kinematic model: existence of solution, multiple solutions, Solution technique, closed form solution.

Unit - IV : Manipulator Differential Motion and Statics

Linear and angular velocity of rigid body, relationship between transformation matrix and angular velocity, mapping velocity vector, velocity propagation along links, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, static analysis.

Dynamic Modeling

Lagrangian Mechanics, Dynamic modeling of two degree of freedom manipulator, Langrange - Euler Formulation, Newtion-Euler formulation, Comparison of Langrange-Euler Formulation and Newtion-Euler formulation, Inverse dynamics.

Unit - V : Trajectory Planning and Introduction to Grippers

Terminology, steps in trajectory planning, joint space technique, Cartesian space techniques. Classification of grippers, selection of grippers, limitation of grippers.

Text Books

1. John J. Craig, Introduction to Robotics Mechanics and Control, Second Edition, Addison Wesly Longman Inc. International Student edition, 1999.
2. R. K. Mittal and I J Nagrath, Robotics and Control, McGraw Hill Education (India) Private Limited, 2017.

Reference Books

1. R. N Jazar, Theory of Applied Robotics: Kinematics, Dynamics, and Control, Springer; 2nd ed. 2010.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT702 **Course : Robotics Sensors and Actuators**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

Understand and apply fundamental concepts of sensors, electro-mechanical fluid power (hydraulics and pneumatics) systems and smart materials in the field of robotics

Course Outcomes

After the completion of the course the student will be able to:

CO1 : Analyse and select the appropriate sensors and actuators for a robotic application.

CO2 : Explain fundamental principle of working of sensors and actuators for robots.

CO3 : Identify key concepts, architecture and principles concerning the hydraulics and pneumatics systems

CO4 : Design the hydraulic and pneumatic circuits based on the required movement and sequence.

CO5 : Evaluate key concepts and principles concerning modelling, analysis, and control of various actuators.

Unit - I

Requirement of sensors in robots used in industry, agriculture, medical field, transportation, military, space and undersea exploration, human-robot interactions, robot control, robot navigation, Teleoperational robot etc. Criteria for selection of sensors- range, dynamic range, sensitivity, Linearity, response time, band width, accuracy, repeatability & precision, Resolution & threshold, type of output, size and weight, environmental conditions, interfacing.

Proprioceptive or Internal sensors Position sensors - encoders - linear, rotary, incremental linear encoder, absolute linear encoder, Incremental rotary encoder, absolute rotary encoder; potentiometers; LVDTs; velocity sensors-optical encoders, tacho generator, Hall effect sensor, ,acceleration sensors, Heading sensors- Compass, Gyroscope sensor, IMU, GPS, real time differential GPS, Force sensors-strain gauge based and Piezo electric based, Torque sensors- Numerical Problems; Electronic skin, microcantilevers; use of Proprioceptive sensors in robots.

Unit - II : Exteroceptive or External Sensors

Contact type, noncontact type; Tactile, proximity- detection of physical contact or closeness, contact switches, bumpers , inductive proximity, capacitive proximity; semiconductor displacement sensor; Range sensors- IR, sonar, laser range finder, optical triangulation (1D), structured light(2D), performance comparison range sensors; motion/ speed sensors-speed relative to fixed or moving objects, Doppler radar, Doppler sound; use of Exteroceptive sensors in robots.

Unit - III : Vision based sensors

Elements of vision sensor, image acquisition, image processing, edge detection, feature extraction, object recognition, pose estimation and visual servoing, hierarchy of a vision system, CCD and CMOS

Cameras, Monochrome, stereo vision, night vision cameras, still vs video cameras, kinect sensor; Block schematic representations.

Unit - IV :

Requirement of actuators for robotic applications, Pneumatic and Hydraulic actuators, physical components, comparison of hydraulic and pneumatic systems- Components of electro hydraulic and pneumatic systems; hydraulic and pneumatic actuators with proportional control valves.

Electric actuators : D. C Motor - Working principle, characteristics, classification, and Speed control techniques and braking, Applications - Speed, direction and position control using H-bridge under PWM mode.

AC Motor : Working principle, Speed torque characteristics, Speed control and braking, Single and three phases DC drives – Speed control of three phase induction motor - chopper drives - Need for V/ F drives - Energy saving AC drives Applications.

Unit - V : Linear Actuation Mechanisms

Belt-driven and screw-driven actuators, pneumatically and hydraulically driven linear actuators, Rack-and-pinion driven actuators, Linear motor driven actuators. Transmission mechanisms-Cams and Cam followers, working principle. Gears and gear trains, ratchet and pawl, belt drive, advantages of belt drive, bearings classification and selection of bearings. Electro thermal, electro-optical and electrochemical actuators.

Smart materials and their application for sensing and actuation, piezoelectric actuator - Linear actuators Hybrid actuators - Applications, shape memory alloys actuator, magnetostrictive actuators, Electrostrictive actuators, Electro - and magnetorheological fluid actuators - Case study.

Reference Books

1. Clarence W. de Silva, Sensors and Actuators: Control System Instrumentation, CRC Press2007, ISBN-13: 978-1420044836
2. Robotics Engineering: An Integrated Approach, by Richard D. Klafter, Prentice Hall Inc.
3. D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.
4. Andre Veltman, Duco W.J. Pulle, R.W. De Doncker, Fundamentals of Electrical Drives (2007), Springer.
5. Pawlak, A. M., Sensors and Actuators in Mechatronics, Design and Applications, TAYLOR AND FRANCIS

Text Books

1. Er. R. K. Rajput, Robotics & Industrial Automation, S. Chand Company
2. John J. Craig, Introduction to Robotics Mechatronics Addison Wesly Longman Inc. Student Edition 1999.
3. Pneumatic Systems, Mujumdar (TMH publication).

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT703 **Course : Mobile Robotics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

This course will present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems.

Course Description

This course introduces the fundamentals of robotics with an emphasis on mobile robots, which are integrated mechanical, electrical and computational systems functioning in the physical world. The course aims to provide both theoretical and practical experience to students through lectures and hands on experiments with real robots and simulation software.

Course Outcomes

At the end of this course students will able to

CO1 : Explain about mobile robot and robot locomotion.

CO2 : Identify and explain the types of locomotion and its kinematic constrain.

CO3 : Explain and apply the concept of mobile robot perception.

CO4 : Use and apply any one of the localization techniques.

CO5 : Apply path planning and navigation algorithms.

Unit - I : Introduction to mobile robots

Mobile robot, definition, types of robots, Applications of Mobile Robot.

Robot locomotion, Types of locomotion - Key issues in locomotion - Wheeled mobile robot - types of wheels - wheel stability - wheel configurations - biomimetic locomotion.

Unit - II : Robot kinematics and dynamics

Forward and inverse kinematics, holonomic and non-holonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.

Unit - III : Perception

Sensors Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), vision-basedsensors, uncertainty in sensing, filtering.

Unit - IV : Localization

Self-localizations and mapping - Challenges in localizations - IR based localizations - vision based localizations - Ultrasonic based localizations - Map representation and Map building - Map based localization scheme – other localization systems.

Unit - V : Introduction to Path Planning and Navigation

Introduction - Competences for Navigation : Planning and Reacting: Path planning: Road map, Cell decomposition, Potential field - Obstacle avoidance: Bug algorithm - A*algorithm - Vector field histogram - Dynamic window approach - Navigation Architectures

Advanced Topics : AI based techniques for navigation, Bio Inspired Algorithm, Multiple robot coordination. Design of intelligent robots.

Text Book

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011

Reference Books

1. S. G. Tzafestas "Introduction to Mobile Robot Control", Elsevier Pub.
2. Selected readings from the research literature, to be distributed in class.
3. Jitendra R. Rao, Ajith K. Gopal, Mobile Intelligent Autonomous Systems, (2012), CRC Press, Taylor and Francis Group. ISBN: 9781439863008.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT704 **Course : Control System Theory**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

To design the control strategy of the robotic systems.

Course Outcome

The students will able to:

CO1 : Understand the concept of system modelling for control strategy.

CO2 : Understand and apply the concept of linear control.

CO3 : Understand and apply the concept of non-linear control.

CO4 : Understand and apply the concept of joint and task space for trajectory planning.

CO5 : Understand the various methods for system stability.

Unit - I : Introduction and System Modeling

Introduction to manipulator control problem, open and closed loop control, forward and inverse dynamics considerations, properties of the dynamic model, introduction to nonlinear systems and control schemes.

Unit - II : Linear Control

Introduction, control techniques, block diagram, transfer function, signal flow diagram, state space representation, performance and stability of feedback control, Proportional-Derivative-Integral (PID) control, selection of PID controller gains, state feedback control, joint controllers.

Unit - III : Nonlinear Control

Introduction, multivariable robot control, linearized control, Proportional-Derivative (PD) control, computed torque control, robust control, adaptive control, Cartesian control, hybrid control.

Unit - IV : Joint Space and Task Space Control Schemes

Introduction, manipulator interaction with environment, compliance control, impedance control, force control, position control, velocity control, trajectory control.

Unit - V : System Stability and Optimal Control

Introduction to Lyapunov stability analysis, direct and indirect methods, time varying optimal control, applications and examples.

Text Books

1. Huang, A., Chien, M. (2010). Adaptive Control Of Robot Manipulators: A Unified Regressor-free Approach. Singapore: World Scientific Publishing Company.
2. Santibáñez, V., Loría Perez, J. A., Loría, A., Davila, V. S., Kelly, R. (2006). Control of Robot Manipulators in Joint Space. Germany: Springer London.
3. Siciliano, B., Bastin, G., Canudas de Wit, C. (2012). Theory of Robot Control. United Kingdom: Springer London.

Reference Books

1. Villani, L., Oriolo, G., Siciliano, B., Sciavicco, L. (2009). Robotics: Modelling, Planning and Control. Germany: Springer.
2. Park, F. C., Lynch, K. M. (2017). Modern Robotics: Mechanics, Planning, and Control. United Kingdom: Cambridge University Press.
3. Dawson, D. M., Abdallah, C. T., Lewis, F. L. (2003). Robot Manipulator Control: Theory and Practice. Ukraine: CRC Press.
4. Hutchinson, S., Spong, M. W., Vidyasagar, M. (2020). Robot Modeling and Control. United Kingdom: Wiley.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT705-1 **Course : Field and Service Robot**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

To introduce the world of field and service robots.

Course Outcome

At the end of this course, the students will able to

CO1 : Learn basic terminology and application of industrial robots.

CO2 : Understand and apply the application of Underwater, Aerial and Space Robots

CO3 : Understand and apply the application of Agriculture, Construction and Mining Robots.

CO4 : Understand and apply the application of Domestic and Medical Robotics

CO5 : Understand and apply the application Humanoids and Intelligent Vehicles.

Unit - I : Industrial robotics

History and evolution of robotics, laws of robotics, robots, robot subsystems, robot configurations, classification of robots, Typical applications- welding, assembly, painting, automated material transfer, machining, human-robot cooperation for handling tasks.

Introduction to parallel manipulators, structure classification of parallel manipulators, applications.

Unit - II : Underwater, Aerial and Space Robotics

Introduction to underwater robotics, historical background, sensor systems, actuating systems, applications. Introduction to aerial robotics, historical background, unmanned aerial vehicles, quadrotors, components of autonomous flight, applications and challenges of aerial robotics.

Introduction to space robotics, historical background, orbital robotics systems, surface robotic systems, applications and examples.

Unit - III : Agriculture, Construction and Mining Robotics

Introduction to agricultural robotics, overview of the agricultural robots, typical applications, challenges of the field.

Introduction to robotics in construction, system overview, basic types of construction robots, economic aspects, applications.

Introduction to robotics in mining, historical background, applications in mining process.

Unit - IV : Domestic and Medical Robotics

Introduction to home automation, domestic robotics, cleaning robots, lawn moving robots, challenges and applications.

Introduction to medical robotics, historical background, surgical robots, rehabilitation robots, exoskeletons, issues related to safety and ethics, applications and challenges in medical robotics.

Unit - 5 : Humanoids and Intelligent Vehicles

Introduction to humanoids, historical background, locomotion and manipulation of humanoids, whole body activities, teaching methodologies, applications.

Concept of intelligence, need and necessity of intelligent vehicles, driver assistance systems, driver monitoring systems, road scene interpretation, automated vehicles, applications and challenges.

Reference Books

1. Industrial Robotics: Technology, Programming and Applications, by Groover M.P., Tata McGraw Hill Publication Ltd.
2. Parallel Robots: Mechanics and Control, by Taghirad H.D., CRC Press.
3. Underwater Robotics: Science, Design & Fabrication, by Moore S.W.,Bohm H., and ,Jensen V., Marine Advanced Technology Education (MATE) Center, 2010.
4. Aerial Robots: Aerodynamics, Control and Application, by Mejia O.D.M., Gomez J.A.E., (eds.), InTech Open Publications.
5. Robot Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction, by Bock T., Linner T., Cmbridge University Press,
6. Robotics and Mechatronics for Agriculture, by Zhang D., Wei B., (eds.), CRC Press.
7. Medical Robotics, by Schweikard A., Ernst F., Springer Publications.
8. Household Service Robotics, by Xu Y., Qian H., and Wu X., Zhejiang University Press.
9. Springer Handbook of Robotics, by Khatib O., (ed.), Springer Publications.
10. Humanoid Robotics: A Reference, Vadakkepat P., Goswami A.,Springer Netherlands, 2017.
11. On Road Intelligent Vehicles, by Kala R., Elsevier Publications, 2017.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT705-2 **Course : Industrial Internet of Things**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

For developing the IoT based technologies in various engineering applications

Course Outcomes

The expected learning outcome is that the students will be able to:

CO1 : Understand the components of IoT systems.

CO2 : Formulate building blocks of IoT.

CO3 : Apply IoT protocols.

CO4 : Analyse outcomes of implemented IoT framework/architecture.

CO5 : Create IoT applications to specific engineering domain.

Syllabus

Unit - I : The Internet of Things : An Overview Internet of Things, Conceptual framework and architecture, Internet of Things, Machine to Machine (M2M).

Unit - II : Internet Principles : The IP Protocol Suite (TCP/IP), IPv6, Application Layer Protocols: HTTP, Encrypted HTTP, Other Application Layer Protocols.

Unit - III : Communication Protocols : Networking and communication protocols, Application layers, standard libraries, Blutooth, Wifi, Zigbee, WSN.

Unit - IV : Introduction to Arduino sketch Programming : Microcontroller and microprocessor, Arduino and Raspberry pi hardware, Intel Adison, Gallilio, RFID, ARM Cortex boards.

Unit - V : Applications of IoT : Case studies or mini projects in some of the areas like: Home Automation, Agriculture sector, health sector, Automotive etc.

Text Books

1. Internet of Things, Architecture and Design principles, Raj Kamal, 1st Edition, McGraw Hill education (India) Pvt. Ltd.
2. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, 1st Edition John Wiley and Sons, Ltd.

Reference Books

1. Learning of Internet of Things, Peter Waher, 1st Edition, Packt Publishing
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAP706 **Course : Robotics and IOT Lab**

L: 0 Hrs. T: 4 Hrs. P: 0 Hrs. Per week **Total Credits : 02**

Course objective

To facilitate exposure to real life engineering applications based on robotic and IoT systems.

Course outcomes

CO1 : Understand the construction and working of robotic and IoT system

CO2 : Implementation of kinematics and dynamics solution for performing the task.

CO3 : Creating demonstrable IoT applications to provide automation solution

Contents

1. Understand the basic construction and working of articulated robots.
2. Explore the online and offline teaching mode to perform specific task.
3. Demonstration of forward and inverse kinematic solution to perform welding and pick and place operation.
4. Develop engineering applications through IoT integrated development environment (IDE).

Reference

1. Robotics and Automation Handbook, edited by Thomas R. Kurfess Ph.D., P.E., CRC Press.
2. Yaskawa Arc welding robot user manual
3. MOTOSIM user manual
4. IoT Applications – Arduino, Raspberry Pi.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAP707 **Course : Product Lifecycle Management Lab**

L: 0 Hrs. T: 0 Hrs. P: 4 Hrs. Per week **Total Credits : 02**

Course Objective

To facilitate exposure to real life engineering applications based on robotic and IoT systems.

Course Outcomes

After completing this course, students will be able to:

CO1 : Demonstrate the ability to operate a CAD/CAE software in conjunction with PLM environment.

CO2 : Analyze physical phenomenon.

CO3 : Apply reverse Engineering Techniques.

Syllabus

This Course consists of geometric modelling using CREO software, Structural analysis by Ansys Software, 3D- Printing for Product Development

Text Book

1. Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International Edns, 1999.

Reference Books

1. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303.
2. Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003).
3. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer Verlag, 2004. ISBN 1852338105.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAP708 **Course : Design Thinking, Innovation and Entrepreneurship**

L: 0 Hrs. T: 0 Hrs. P: 4 Hrs. Per week **Total Credits : 02**

Course Outcomes

After completing this course, students will be able to learn:

CO1 : Understand the creative problem-solving process and components involved.

CO2 : Apply the different creativity tools for idea generation and inculcation.

CO3 : Demonstrate the ability to develop and idea from scratch and turn in to a possible source for entrepreneurship.

Syllabus

Unit - I : Introduction to creativity

Making a case for creativity, Creative thinking as a skill, and valuing diversity in thinking: Thinking preferences, Creativity styles, Creativity in problem solving.

Unit - II : Creativity Thinking Tools

Pattern Breaking: Thinking differently, Lateral thinking, Mind stimulation: games, brain-twisters and puzzles, Idea- collection processes, Brainstorming/Brain-writing, The SCAMPER methods, Metaphoric thinking, Outrageous thinking, Mapping thoughts, Other (new approaches)

Unit - III : Tools for Conflict Resolution and Idea Generation

Systematic Inventive Thinking: Systematic inventive thinking: The TRIZ methodology, Decision and Evaluation: Focused thinking framework, six thinking hats, Ethical considerations. Using Math and Science, Systematic logical thinking, Using math concepts, Eight-Dimensional (8D) Approach to Ideation: Uniqueness, Dimensionality, Directionality, Consolidation, Segmentation, Modification, Similarity, Experimentation

Text Book

1. Creative Problem Solving for Managers - Tony Proctor - Routledge Taylor & Francis Group.

Reference Books

1. 101 Activities for Teaching creativity and Problem Solving - By Arthur B Vangundy - Pfeiffer.
2. H. S. Fogler and S.E. LeBlanc, Strategies for Creative Problem Solving, Prentice Hall.
3. E. Lumsdaine and M. Lumsdaine, Creative Problem Solving, McGraw Hill,.
4. J. Goldenberg and D. Mazursky, Creativity in product innovation. Cambridge University Press, 2002.

Syllabus for Semester - I
M. Tech. (Robotics and Automation)

Course Code : RAT709 **Course : Professional Practices and Ethics**

L: 1 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 01**

Course Objective

To acquaint the students with the professional and safe practices in the industries and instil and Redevelop in them ethical and moral values expected in the engineering profession and research.

Course Outcomes

At the end of this course students will demonstrate the ability to:

CO1 : Practice the moral values of a good human being and a responsible citizen.

CO2 : Understand the ethical dimensions of the business, research activities etc. and act in an ethical manner.

CO3 : Demonstrate professional approach, conduct and behaviour in the job.

CO4 : Understand the concepts of safety and ensuring safety at the workplace.

CO5 : Follow the concepts of sustainable development and corporate social responsibility

Unit - I

Introduction to morals, ethics and human values in professional and personal life. Universal human values. Human rights and employee rights. Practicing gender equality.

Unit - II

Engineering ethics. Relevance and importance of following ethical approach in business and research. Ethical and moral dilemmas and challenges. Codes of ethics.

Unit - III

Understanding the professional practices in the industry necessary for effective working and adapting to the work culture of the corporate world. Developing professional approach towards work and developing communication and presentation skills.

Unit - IV

Introduction to safety and responsibility of safety. Safety at the workplace.

Unit - V

Role of engineers in serving the society and in ensuring sustainable development. Awareness about corporate social responsibility meaning, scope etc.

Reference Books

1. Professional Ethics and Human Values by R. S Naagarazan, New Age International Publishers.
2. Professional Ethics by R. Subramanian , Oxford.
3. Professional Ethics and Human Values by Premvir Kapoor, Khanna Publishing.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT721 **Course : Advanced Industrial Automation**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Prerequisites

Digital circuits, Control System, Sensors and Transducers, Actuators and drives

Course outcomes

At the end of this course students will be able to:

CO1 : Understanding the automation , and process control.

CO2 : Gain knowledge of PLC architecture and interfacing modules.

CO3 : Achieve confidence in development of PLC ladder logic for industrial applications.

CO4 : Develop of SCADA / HMI for industrial processes.

CO5 : Apply cutting edge technologies for next level of industrial automation.

Unit - I : Fundamentals of automation and logic controller

Definition, automation principles and strategies, Architecture of Industrial Automation Systems, Logical operations, Numbering System, Data types, Basic electrical diagram, Manual and Relay logic controller, Process Control Classification: Interlock control, Sequential control and, Random control.

Unit - II : Industrial field instruments

Buttons, Limit switch, Level switch, Digital proximity sensors: Inductive, Capacitive, Photo, Magnetic, NPN-PNP type sensors, Rotary encoders, Sensor interfacing, Signal Transmitters , HART protocols, Sensor interfacing, Types of Analog Modules, Signal standards, Voltage- current transmitter, Relays and Contactors, Solenoids, AC Motor and DC Motors, Pneumatic actuators, Introduction to communication protocols- Profibus, Field bus.

Unit - III : Programmable Logic controller (PLC) Architecture

Micro controller vs PLC, History of PLC, PLC manufacturers, PLC standards IEC-61131, PLC Architecture, Image memory concept, File descriptor tables, Interfacing Input and Output devices with PLC, PLC based automated systems, High frequency inputs, , types of variables , software tool and interfacing with PC (RS232 &PN/IE), selection of PLC controller.

Unit - IV : PLC Ladder Programming

Methods of PLC programming: LD, ST, FBD & SFC, Latching and internal relays, Bit Logic Instructions: latch, master control self-holding relays, Interlocking, Timers and Counters, Programming Exercises, Data conversion Instructions, Compare instructions, Data Handling Instruction, Arithmetic Instruction, Pulse instruction: Positive pulse, negative pulse, Examples based on pulse, PLC analog operations, case studies, PID Modules, PID Tuning, Typical PID Functions.

Unit - V : SCADA \ HMI, and DCS

Elements of SCADA\HMI, Features of SCADA\HMI, MTU, RTU Functions, Communications in SCADA, and Development of SCADA\HMI for industrial processes, Case studies, Web server, HTML based GUI developments.

Introduction to Distributed control system, Architecture, Input and output modules, and Case studies. Comparison of Programmable Logic controller and Programmable automation controller.

Text Books

1. Programmable Logic Controllers, Principles and Applications: John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd.
2. SCADA supervisory control and data acquisition: Stuart A. Boyer, ISA Publication.

Reference Books

1. Process Control Instrumentation Technology: Curtis Johnson, 8th Edition, Pearson Education.
2. Programmable Logic Controllers: Bolton, Elsevier India; Fifth edition (2010).
3. Programmable Logic Controllers: Frank D. Petruzella McGraw Hill; Fifth.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT722 **Course : Artificial Intelligence and Machine Learning in Robotics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

To introduce concepts and methods of Artificial Intelligence and Machine Learning and to develop an understanding of the role of Artificial Intelligence and Machine Learning used in the field of robotics.

Course Outcomes

The students will be able to

CO1 : Understand basic concepts and apply the techniques of Artificial Intelligence.

CO2 : Understand and apply AI with limited human-like capabilities, especially in the form of search-based problem solving.

CO3 : Demonstrate the Application of Planning in AI & ML Application.

CO4 : Apply uncertainty theory based on techniques like probability theory and fuzzy logic.

CO5 : Apply machine learning models to solve real-life problems.

Unit - I : Introduction to Artificial Intelligence

Introduction: Philosophy of AI, Definitions, History, Typical AI problems, Intelligent behavior, Practical Impact of AI, Approaches to AI, Limits of AI, Need for AI in Robotics.

Introduction to Agents, Agent Performance, Examples of Agents, Intelligent Agents, Agent architectures.

Unit - II : Problem Solving using Search

Introduction to State Space Search, Uninformed Search, Breadth First Search, Depth First Search, Iterative Deepening, A-star etc.

Knowledge Representation and Reasoning.

Unit - III : Planning

Planning with forward and backward state space search, partial order planning, planning graphs, planning with propositional logic, planning and acting in real world.

Unit - IV : Reasoning with Uncertainty

Introduction, uncertainty, probabilistic reasoning, filtering and prediction, Hidden Markov models, Kalman filters, Dynamic Bayesian Networks, making decisions. Fuzzy Logic, Introduction, Fuzzy sets, Fuzzy model, Fuzzy rule generation Fuzzy inference system, Defuzzification. Uncertainty modeling in expert system, Fuzzy control, Applications and Case Studies in Robotics.

Unit - V : Machine Learning

Introduction to machine learning, learning input- output functions, types of learning, Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning. Decision trees and inductive bias. Fundamentals of Artificial Neural Networks & Applications Feed Forward Neural Networks, Back propagation. Applications and Case Studies in Robotics.

Text Books

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, India,2016.
2. Michalski, Carbonell, Tom Mitchell, 'Machine Learning', Springer, 2014

Reference Books

1. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992.
2. Huimin Lu, Xing Lu, "Artificial Intelligence and Robotics", Springer, 2017.
3. David MacKay, 'Information Theory, Inference and Learning Algorithms', Cambridge, 2003
4. Rogers, S., Girolami, M. (2016). A First Course in Machine Learning, Second Edition. United Kingdom: CRC Press.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT723 **Course : Research Methodology**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

At the end of the course the student will be able to:

1. Get an overview of the research methodology and become familiar with various steps in a scientific research.
2. Plan, execute the research work and present it.

Course Outcomes

At the end of the course the student will be able to:

CO1 : Understand the concept and process of Research and its Methodology.

CO2 : Formulating a research problem and frame the hypothesis.

CO3 : Demonstrate the details of sampling designs and different methods of data collections.

CO4 : Apply various tools and soft computing methods in research.

CO5 : Write research articles and understand various forms of the intellectual property.

Introduction

Meaning & Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Importance of Knowing How Research is done, Research Process, Steps in research, Criteria of good Research.

Literature Review and Formulating a Research Problem

Significance of Literature Review, Procedure for reviewing the literature, Analysis of Literature Review - Primary and Secondary Sources, Web sources - critical Literature Review, Sources of a Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques involved in defining a Problem.

Data Collection and Analysis

Sources of Data - Primary, Secondary and Tertiary - Types of Data - Categorical, nominal Collection of Primary Data, Various Methods of Data Collection, Data Analysis, Sampling methods - Need for Sampling, Sampling Distributions, Sample Size Determination Data Processing and Analysis strategies- Graphical representation Descriptive Analysis Inferential Analysis- Correlation analysis Least square method - Data Analysis using statistical package Hypothesis testing Generalization and Interpretation Modeling.

Computing Tools and Techniques in Research

Introduction to spreadsheet application, features and functions, using formulae and functions, Data storing, Statistical data analysis, generating charts/ graph and other features, Use of statistical Analysis software. Introduction to soft computing techniques. Case study on the research problems related to Robotics and automation.

Text Books

1. Research Methodology: Methods and Techniques, Kothari C.K. (2004), 2/e, New Age International, New Delhi.
2. Research Methodology: A Step by Step Guide for Beginners, 2nd ed.: Ranjit Kumar: Pearson.

Reference Books

1. Design and Analysis of Experiments: Angela Dean and Daniel Voss, Springer-Verlag New York.
2. Theories of Engineering Experimentation, 1st ed.: H. Schenck Jr., Mc-Graw Hill.
3. Simulation Modeling and Analysis, 2nd ed.: Law, A. M, W. D. Kelton, 1991, McGraw Hill.
4. Applied Statistics & Probability for Engineers: Montgomery, Douglas C. & Runger, George C. (2007), 3/e, (Wiley India).

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT724-1 **Course : Bioinspired Robotics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

For understanding the robotic systems in the context of biologically inspired robotic applications.

Course Outcomes

The expected learning outcome is that the students will be able to:

CO1 : Understand the Bioinspired sensing.

CO2 : Formulate bioinspired motion

CO3 : Differentiate Soft and Hard Robotics

CO4 : Analyse control architecture and behaviour with reference to kinematics

CO5 : Evaluate collective and Biohybrid robotics/ create electromechanical robotic system

Syllabus

Unit - I : Fundamentals of Traditional Robots, Biologically-inspired Robots, Introduction, Bio-inspired morphologies, Bio-inspired sensors, Vision, Audition, Touch, Smell, taste, Idiothetic sensors.

Unit - II : Fundamentals of Biologically Inspired Robots, Bio-inspired actuators, locomotion, crawling, walking, wall climbing, jumping, swimming, flying, grasping, drilling.

Unit - III : Soft Robotics, Structural Difference between Hard and Soft Robots, Bio-inspiration in Soft Robotics, Hydrostatic Skeletons, Muscular Hydrostats, Soft Active Plant Structure, Soft Robots, Actuators, Pneumatic Artificial Muscles, Electroactive Polymers, Shape Memory Alloys.

Unit - IV : Bio-inspired control architectures, Behavior-based robotics, learning robots, Evolving robots, Developing robots, Bio-inspired Robot Design Considering Load-bearing and Kinematic Ontogeny of Sea Turtles.

Unit - V : Energetic anatomy, Collective robotics, Biohybrid robots. Case studies and mini projects in Design and Fabrication of Biologically Inspired Robots

Text Books

1. J.J. Craig. Introduction to Robotics: Mechanics and Control. Prentice Hall; 3rd edition, 2003.

Reference Books

1. Handbook of Robotics, Jean-Arcady Meyer and Agnès Guillot
2. Karl Williams. Amphibionics: Build Your Own Biologically Inspired Reptilian Robot. McGraw-Hill/TAB Electronics, 2003.
3. David Cook. Robot Building for Beginners. Apress, 2002.
4. G. A. Bekey. Autonomous Robots. MIT Press, 2005.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT724-2 **Course : Supply Chain Management**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

Understand the strategic importance of Supply Chain Design, Planning and execution for discreet product manufacturing

Course Outcomes

After completing this course, students will be able to:

CO1 : Identify the nature of Supply Chain, Basic Concepts, Supply Chain Performance and Supply Chain Drivers

CO2 : Identify the critical factors in a distribution network and transportation network of a product for an enterprise.

CO3 : Demonstrate the different analytical methods for forecasting and managing the demand for monitoring the inventory

CO4 : Apply the different measures of Product Availability and Understand the Role of Safety Inventory in Supply Chain.

CO5 : Manage Cross Functional drivers in a Supply Chain.

Unit - I : Building a Strategic Framework to Analyze Supply Chains

Understanding the Supply Chain : What is Supply Chain, Historical Perspective, The Objective of a Supply Chain, The Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, and Process Views of a Supply Chain.

Supply Chain Performance : Achieving Strategic Fit And Scope : Competitive and Supply Chain Strategies, Achieving Strategic Fit, Expanding Strategic Scope, Challenges to Achieving and Maintaining Strategic Fit, Achieving and Maintaining Strategic Fit in Emerging Retail Markets: The Indian Scenario, The Experience, Adaptation.

Supply Chain Drivers And Metrics : Impellers of Supply Chain, Financial Measures of Performance, Drivers of Supply Chain Performance ,Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing, Infrastructure, International Logistics.

Unit - II : Designing the Supply Chains Network

Designing Distribution Networks And Applications To Online Sales : The Role of Distribution in the Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, Online Sales and the Distribution Network, Indian Agricultural Produce Distribution Channels: Ripe for Major Transformation, Indian fmcg Sector-Distribution Channels, Indian Commodities Distribution Channels, Distribution Networks in Practice.

Network Design In The Supply Chain : The Role of Network Design in the Supply Chain, Factors Influencing Network Design Decisions, Framework for Network Design Decision, Models for Facility Locations and Capacity Allocation, Jaipur Rugs- Networking Tradition with Modernity, The Impact of Uncertainty on Network Design.

Unit - III : Planning and Coordinating Demand and Supply in a Supply Chain

Demand Forecasting in a Supply Chain : The Role of Forecasting in a Supply Chain, Characteristics of Forecasts, Components of a Forecast and Forecasting Methods, Basic Approach to Demand Forecasting, Time-Series Forecasting Methods, Measures of Forecast Error, Selecting the Best Smoothing Constant, Forecasting Demand at Tahoe Salt, The Role of IT in Forecasting.

Sales and Operations Planning : Planning Supply And Demand in a Supply Chain: Responding to Predictable Variability in the Supply Chain, Managing Supply, Managing Demand, Sales and Operations Planning at Red Tomato, Implementing Sales and Operations Planning in Practice.

Coordination in a Supply Chain : Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning, Forecasting and Replenishment.

Unit - IV : Planning and Managing Inventories in a Supply Chain

Managing Economies of Scale in a Supply Chain : Cycle Inventory: The Role of Cycle Inventory in a Supply Chain, Estimating Cycle Inventory Related Costs in Practice, Economies of Scale to Exploit Fixed Costs, Aggregating Multiple Products in a Single Order, Economies of Scale to Exploit Quantity Discounts, Short term Discounting: Trade Promotions, Managing Multiechelon Cycle Inventory, Cycle Inventory Optimisation in Indian Distribution Channels.

Managing Uncertainty in a Supply Chain : Safety Inventory : The Role of Safety Inventory in a Supply Chain, Factors Affecting the Level of Safety Inventory, Determining the Appropriate Level of Safety Inventory, Impact of Supply Uncertainty on Safety Inventory, Impact of Aggregation on Safety Inventory, Managing Uncertainty in Supply Chain Through Postponement –Indian Paint Industry, Impact of Replenishment Policies on Safety Inventory, Managing Safety Inventory in a multiechelon Supply Chain, The Role of IT in Inventory Management.

Unit - V : Manage Cross Functional drivers in a Supply Chain

Sourcing Decisions In A Supply: The Role Of Sourcing In A Supply Chain, Inhouse Or Outsource Total Cost Of Ownership, Supplier Selection - Auctions And Negotiations, Sharing Risk And Reward In The Supply Chain. The Impact Of Incentive When Outsourcing, Designing A Sourcing Portfolio, Making Sourcing Decisions.

Pricing and Revenue Management in Supply Chain : The Role of Pricing and Revenue Management for Multiple Customer Segments, Perishable Assets, Seasonal Demand, Bulk and Spot Contracts.

Sustainability and Supply Chain : The Role of Sustainability in Supply Chain, Key Pillars of Sustainability, Sustainability and Supply Chain Drivers, Pricing Of Sustainability.

Programme Scheme & Syllabi M. Tech. (Robotics & Automation)

Text Books

1. Supply Chain Management: BY Sunil Chopra and Peter Meindl - Pearson Education, Asia.

Reference Books

2. Designing and Managing the Supply Chain, Simchi-levi & Kaminsky, and McGraw-Hill Publication.
3. Logistics and Supply Chain Management, D.K. Agarwal

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT725-1 **Course : Robotic Process Automation**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

To develop the processes using RPA & cognitive services of Blue Prims, UiPath, Automation Anywhere, for various automation applications.

Course Outcomes

The expected learning outcome is that the students will be able to:

CO1 : Understand Robotic Process Automation (RPA) and its value proposition.

CO2 : Understand various RPS skills.

CO3 : Learn different RPA tools and use different component to automate process.

CO4 : Learn and use Web, Email, Excel, Database, API etc. and Image Automation.

CO5 : Understand RPA services and its integration with RPA Tools.

Unit - I : Robotic Process Automation (RPA) Foundation

Overview of RPA, Development of RPA, Evolution of RPA, Differentiating RPA from Automation, Assisted and unassisted automation, Defining Robotic Process Automation & its benefits, comparison to other automation technology.

Unit - II : RPA Skills

On premise Vs. the cloud, Web Technology, Programming Languages and low code, OCR, APIs, Cognitive automation, flowchart

Unit - III : Process Methodologies

Lean, Six Sigma, Applying lean and Six Sigma to RPA.

Unit - IV : Planning and BOT Development

How Robotic Process Automation works, RPA development methodology and key considerations, Robotic Process Automation Tools. Sequence flowchart and control flow, various types of loops and decision making, Introduction to UiPath platform and its components, Types of Templates, User Interface Domains in Activities Workflow, and Files in UiPath.

Automate login to your (web) Email account Recording mouse and keyboard actions to perform an operation Scraping data from website and writing to CSV/Excel Programming, Debugging and Logging.

Deployment and Monitoring, Data Preparation, RPA Vendors, Blue Prism, UiPath platform etc. Open Source RPA, Future of RPA.

Unit - V : Applied Mechatronics

Principle of working of automatic camera, engine management system. Pick and Place robot, Mechatronics design in Automated car parking system, Automated Washing Machine System, Automated Traffic signal Method, Case studies in: Mechatronics in Home appliances, Medical Devices, Defense, Automobiles and office automation, Industrial Automation, Future of Mechatronics.

Text and Reference Books

1. Taulli T. Process Mining. The Robotic Process Automation Handbook 2020 : A Guide to Implementing RPA System (pp. 273-292). Apress, Berkeley, CA.
2. Tripathi AM. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool-UiPath. Packt Publishing Ltd; 2018 Mar 28.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT725-2 **Course : Product Life Cycle Management (PLM)**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to prepare the students:

1. Understand the various strategies of PLM, concept of product design, development, simulation and support system
2. Interpret the technology forecasting, product innovation, product building & configuration and apply in business processes.

Course Outcomes

After completing this course, students will be able to:

CO1 : Understand the prerequisites for PLM and the impact of its implementation on Organizations.

CO2 : Develop the architecture of PLM and its functioning for the organization.

CO3 : Demonstrate the ability to operate a CAD/CAE software in conjunction with PLM environment.

CO4 : Apply product building tools.

CO5 : Analyze product structure.

Syllabus

Unit - I : Introduction to PLM and PDM

Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, Design Thinking, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.

Unit - II : Product Design

Engineering design, organization and decomposition in product design, product design process, Management of product data interfaces, GD&T, annotations, manufacturing notes, Integration of CAM with PLM. PLM methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product

Unit - III : Product Development

New Product Development, structuring new product development, building decision support system, estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.

Unit - IV : Product Building and Structures

Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis (FEA), production (process) planning, and product data technology.

Unit - V : Product structures

Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items. Introduction to augmented reality, Digital twin and IOT.

Text Books

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006

Reference Books

1. Saaksvuori Antti / Immonen Anselmie, product Life Cycle Management Springer, Dreamtech,3-540-25731-4
2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill
3. Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International Edns, 1999.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAP726 **Course : Integrated Advance Manufacturing Lab**

L: 0 Hrs. T: 0 Hrs. P: 4 Hrs. Per week **Total Credits : 02**

Course Objectives

The objective of the course is to prepare the students for understanding and familiarity with CNC programming and automation technology, thereby its role in automation field.

Course Outcomes

At the end of this course students will be able to:

CO1 : Execution of CNC programming and CMM technology through various machine tools available.

CO2 : Understand the working of the material handling systems.

CO3 : Understand the knowledge of automation in terms of automated flow line.

List of Experiments

Expt - 1 : To study CNC operating panel and fanuc interface.

Expt - 2 : To study program of instructions: G-Codes & M-Codes.

Expt - 3 : To study ATC operations & work-offset.

Expt - 4 : To perform CNC - Lathe Programming and operational execution.

Expt - 5 : To perform CNC - Milling Programming and operational execution.

Expt - 6 : To study automated material handling and execution systems.

Expt - 7 : To study the Coordinate Measuring Machine (CMM)

Expt - 8 : To study automated flow line (AFL) & transfer line mechanism.

Text Books

1. Automation, production System & CIMS: M. P. Groover, Prentice Hall of India, New Delhi
2. CNC Machines: M. Adithan& B. S. Pabla, New Age International Publications New Delhi

Reference Books

1. CAD/CAM: M. Groover& E. Zimmers , Pearson Education, Delhi
2. Industrial Engg. & Production Management : Martand Telsang, S. Chand Publications, Delhi
3. Computer Control of Manufacturing Systems: Yoram Koren, Mcgraw Hill, Delhi

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAP727 **Course : Industrial Automation Lab**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Outcomes

CO1 : Demonstrate the TIA portal and Siemens PLC for various Industrial Applications.

CO2 : Able to understand PID controller and Sensor Interfacing.

CO3 : Able to apply the knowledge of Data Acquisition System & web server for HTML based HMI.

Lab would be conducted covering the following case studies along with mini project.

Platforms

Siemens 12XX PLC, KTP700 HMI, Miniaturized Production System (MIPS) with 1500 modular PLC, Motor Speed control using PID controller trainer, Ferrous-nonferrous Sorting setup, Contactors, Siemens Variable frequency drive.

Case studies:

Demonstration of TIA portal, and Siemens PLC, On-off control, Motor direction control, Sequential motor control, Bottles filling and sorting operation, Star-Delta Starter, DOL Starter, Material mixing application, Lubrication cycle application, Object counter, Real Time Clock, Car parking, Traffic light control, Room- automation, Analog operations, PID controller, Sensor interfacing and data acquisition, HMI development, Webserver for HTML based HMI and other case studies.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAP728 **Course : Seminar (Project Based Learning) Lab**

L: 0 Hrs. T: 0 Hrs. P: 4 Hrs. Per week **Total Credits : 02**

Course Objective

In this course the students will acquire the knowledge through active participation by solving real word problem in the domain of robotics and automation.

Course Outcome

Student will be able to:

CO1 : Carry out the detailed literature survey and identify the research gap to frame the problem statement.

CO2 : Formulate the appropriate methodology to design the solution.

CO3 : Prepare the technical reports and present the findings effectively.

Syllabus

The seminar topic should be latest and ahead of the scope of curriculum. The exhaustive literature review should be conducted to identify the research gap. The performance of the student will be evaluated on the basis of the contents, the presentation and discussion during the delivery of the seminar in front of the evaluation committee appointed by the Department.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT799-1 **Course : Industrial Robotics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

Understand the concept of kinematics and dynamics of robots, various actuation & sensing systems and control strategy to develop the complete robotic system.

Course Outcomes

The expected learning outcome is that the students will be able to:

CO1 : Recognize the fundamentals, evolution and advancement of Robotics.

CO2 : Suggest and select drives and end effector of robot.

CO3 : Develop the dynamics and trajectory planning for manipulators.

CO4 : Describe the Sensing, Actuation and control issues of robots.

CO5 : Develop the ability to perform kinematic analysis of manipulators.

Syllabus

Unit - I

Introduction to robots, Definition and their evolution, Anatomy and classification of robots, what is and what is not a robot, progressive advancements in robots. Co-ordinate Systems, Work Envelope, types and classification Specifications, Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and Functions - Need for Robots - Different Applications, Principles and problems in robot design and control. Various application of robots in industrial and non-industrial domain.

Unit - II : Robotics Drives and Grippers

Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives - D.C. Servo Motors, Stepper Motor, A.C. Servo Motors - Salient Features, Applications and Comparison of Drives. End Effectors - Grippers - Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

Unit - III : Robotic Sensors Sensors

Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. Applications– Inspection, Identification, Visual Serving and Navigation.

Unit - IV : Robot Programming and Control Robot programming

Programming of Robots and Vision System - overview of various programming Languages. Control architecture- position, path velocity and force control systems, computed torque control, Adaptive control, and Servo system for robot control.

Unit - V

Kinematics of serial robots Coordinate frame, mapping and transformation, Forward & inverse kinematics, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms. Introduction to trajectory planning and dynamics of robots.

Text Books

1. R. K. Mittal, I. J. Nagrath, “Robotics and Control”, McGraw Hill Education, 2017.

Reference Books

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J., “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT799-2 **Course : Mechatronics**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

This course aims at providing fundamental understanding about the basic elements of a mechatronics system, interfacing, and its practical applications.

Course Outcomes

The expected learning outcome is that the students will be able to:

CO1 : Understand and recognize the synergistic combination of all related branches of engineering.

CO2 : Apply knowledge about sensors and actuators for selection for a typical application.

CO3 : Recognize CNC machines as Mechatronic systems.

CO4 : Understand and apply the design process a Mechatronics system.

CO5 : Gain the knowledge on advanced applications in mechatronics.

Syllabus

Unit - I : Introduction

Introduction to Mechatronics Systems, Definition of Mechatronics, Classification and Description of Mechatronic using Graphical and Block Diagram Method, Multi-disciplinary scenario, origins. Evolution of Mechatronics, Mechatronics key elements, Mechatronics design process, Mechatronics in home, office and industry automation, Scope of Mechatronics, Objectives, advantages and disadvantages of mechatronics.

Unit - II : Sensors and Transducers

Introduction to Sensors and Transducers: Performance Terminology Displacement, Position and Proximity - Velocity and Motion-Fluid, Classifications of different sensors used in mechatronics systems.

Unit - III : Actuators

Classifications of Actuators, Types of stepper motors and its control circuit, Types of DC Motor, DC Geared motors, SD Servo geared Motors, Mechanical Actuation Systems, Pneumatic and Hydraulic Actuation Systems. Smart materials, Smart materials and their application for sensing and actuation, Mechatronics aspects. Piezoelectric actuators, Introduction to Microprocessors and Micro Controllers used for Mechatronic devices.

Unit - IV : Mechatronics Elements in CNC Machine Tools

Introduction to Computer Numerical Control, Features of CNC Machines, Structure, Drive Mechanism, Description of a simple CNC control system. Types of measuring systems in CNC machines

Unit - V :Design of Mechatronics System

Stages in designing Mechatronics Systems - Traditional and Mechatronic Design - Possible Design Solutions, Intelligent techniques in mechatronics – algorithms man machine interface- case studies.

Applied Mechatronics : Principle of working of automatic camera, engine management system, and automatic washing machine. Pick and Place robot, Mechatronics design in Automated car parking system, Automated Washing Machine System, Automated Traffic signal Method,. Case studies in: Mechatronics in Home appliances, Medical Devices, Defense, Automobiles and office automation, Industrial Automation, Future of Mechatronics.

Text Books

1. W. Bolton,"Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - 4thEdition.Pearson Education; 4 edition (2010).
2. Principles, Concepts and applications - Mechatronics - Nitaigour and Premchand Mahilik - Tata McGraw Hill - 2003.

Reference Books

1. Devdas Shetty and Richard A. Kolk "Mechatronics System design"2nd Edition Cengage learning, (2012).
2. Kutan, Appu KK. Introduction to mechatronics. Oxford University Press, New Delhi.

Syllabus for Semester - II
M. Tech. (Robotics and Automation)

Course Code : RAT799-3 **Course : Electric & Hybrid Vehicle Technology**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The objective of the course is to

1. To give comprehensive insight into the electric vehicle domain, including EV architecture, e-motors, energy storage systems and their control.
2. To expose students to the process of motor sizing, selection of batteries, range and charging time calculations for XEV applications.

Course Outcomes

On completion of this course the students will be able to

CO1 : Enlist the benefits of EVs and differentiate between various EV architectures

CO2 : Analyze the tractive force requirement and chose type of e motor to be used for given application.

CO3 : Compare various battery technologies and Identify application specific battery and energy management system

CO4 : Outline modes and types of chargers and emphasize the importance of vehicle to grid communication.

CO5 : Demonstrate the safety requirements as per various AIS standards for EVs and subsystems.

Syllabus

Unit - I : Introduction to Electric Vehicles

History, current perspective of EV, advantages and challenges, EV Efficiency, EV architecture.

Unit - II : EV Drives and Motors

Tractive effort calculation, Motor Sizing, types of Motor for EV; their working, salient features, advantages etc., e-Motor Control, selection criteria.

Unit - III : EV Energy Storage

Li-Ion Battery, different battery chemistry and their comparison, Types of Cell Construction, pack and battery modules. Terminologies related to batteries, Convertors and Inverters, Battery Management System

Unit - IV : EV Charging & Charging Infrastructure

Types of charging, charging modes, charger types, Communication between vehicle and grid, G2V, V2G. Contactless charging, battery swapping, standards for charging infrastructure.

Unit - V : EV Safety, Testing and Certification

Standards for Battery, Motor etc., testing procedure for 2W, 4W, E Rickshaw, Functional Safety, Policy and Business Perspective of EVs.

Advance Topics & Recent Trends

Fuel Cell types and potential of Fuel Cell Electric Vehicle, Hydrogen as fuel, Connected Mobility and Autonomous vehicles.

Text Books

1. Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", Second Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

Reference Books

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", Third Edition, CRC Press, 2018.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAT801-1 **Course : Smart Manufacturing and Digital Twins**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Outcomes

CO1 : Able to understand the applications of Data Analytics in Manufacturing.

CO2 : Able to demonstrate the collection and pre-processing of Data for Smart Manufacturing.

CO3 : Able to apply various Data Analysis tools for Manufacturing.

CO4 : Able to understand the Digital Twin Technology and its Applications.

CO5 : Able to apply the knowledge of digital Twin for cyber - physical systems, process automation and optimization etc.

Unit - I : Data Analytics in Manufacturing

Data analytics in manufacturing, applications, importance, and case studies.

Unit - II : Data Collection & Preprocessing for Smart Manufacturing

The role of data in optimizing processes and improving efficiency, Data collection methods and technologies.

Unit - II : Data Analysis Tools for Manufacturing & Applications

- Advanced Excel
- Tableau & Power Bi
- Alteryx
- Rapid Miner etc.

Unit - IV : Introduction to Digital Twin

Introduction to technologies, applications, opportunities, and challenges influencing digital twin

Unit - V : Manufacturing and Production

Introduction to the impact of the digital twin, cyber-physical systems, process automation and optimization, predictive maintenance and anomaly detection on the manufacturing ecosystem and its application.

Text Books

1. Christoph Jan Bartodziej, "The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics", Spinger Gabler, 2015.
2. Alasdair Gilchrist, "Industry 4.0 – The Industrial Internet of Thigs", Springer Link, 2016
3. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAT801-2 **Course : Economics and Financial Management**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Outcomes

CO1 : Evaluate the economic theories, cost concepts and pricing policies

CO2 : Understand the market structures and integration concepts.

CO3 : Understand the measures of national income, the functions of banks and concepts of globalization.

CO4 : Apply the concepts of financial management for project appraisal.

CO5 : Understand accounting systems and analyze financial statements using ratio analysis.

Unit - I : Economics, Cost and Pricing Concepts

Economic theories - Demand analysis - Determinants of demand - Demand forecasting - Supply - Actual cost and opportunity cost - Incremental cost and sunk cost - Fixed and variable cost - Marginal costing - Total cost - Elements of cost - Cost curves - Breakeven point and breakeven chart - Limitations of breakeven chart - Interpretation of breakeven chart - Contribution - P/V-ratio, profit-volume ratio or relationship - Price fixation - Pricing policies - Pricing methods.

Unit - II : Concepts on Firms and Manufacturing Practices

Firm - Industry - Market - Market structure - Diversification - Vertical integration - Merger - Horizontal integration

Unit - III : National Income, Money and Banking, Economic Environment

National income concepts - GNP - NNP - Methods of measuring national income - Inflation - Deflation - Kinds of money - Value of money - Functions of bank - Types of bank - Economic liberalization - Privatization - Globalization.

Unit - IV :Concepts of Financial Management

Financial management - Scope - Objectives - Time value of money - Methods of appraising project profitability - Sources of finance - Working capital and management of working capital.

Unit - V : Accounting System, Statement and Financial Analysis

Accounting system - Systems of book-keeping - Journal - Ledger - Trail balance - Financial statements - Ratio analysis - Types of ratios - Significance - Limitations.

Text Books

1. Prasanna Chandra, Financial Management (Theory & Practice) TMH
2. Weston & Brigham, Essentials of Managerial Finance

References

1. Pandey, I. M., Financial Management.
2. Fundamentals of Financial Management- James C. Van Horne.
3. http://stanford.edu/dept/MSandE

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAT802-1 **Course : Strategic Project Management**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objective

This course provides the foundation for the students to develop understanding of Strategic Management and its role in creating competitive advantage.

Course Outcomes

CO1 : Students will understand the integrative nature of strategic management and its role in creating competitive advantage.

CO2 : Students will be able to analyse external environment.

CO3 : Students will be able to assess the internal environment of the firm.

CO4 : Students will be able to understand formulation and implementation of business level strategies for creating and sustaining competitive advantage.

CO5 : Students will be able to understand formulation and implementation of corporate level strategies for creating value in domestic and global markets.

Unit - I : Strategic Management

Creating Competitive Advantages What is strategic management? The strategic management process. The strategic management perspective: an imperative throughout the organization. Ensuring coherence in strategic direction. The role of corporate governance and stakeholder management.

Unit - II

Analysing the External Environment of the Firm Enhancing awareness of the external environment, the general environment, the competitive environment.

Unit - III : Assessing the Internal Environment of the Firm Value

Chain analysis, resource-based view of the firm, evaluating firm performance. Recognizing a Firm's Intellectual Assets: Moving beyond a Firm's Tangible Resources.

Unit - IV : Business-Level Strategy

Creating and Sustaining Competitive Advantages Types of competitive advantage and sustainability, industry life-cycle stages: strategic implications. Digital Business Strategy: Leveraging Capabilities in a Disruptive Environment Competitive Disruption, strategic management, and the digital economy, how internet and digital technologies are affecting five competitive forces, competitive strategies and adding value.

Unit - V : Corporate-Level Strategy

Creating Value Making diversification work: an overview, related diversification: economies of scope and revenue enhancement, related diversification: market power, unrelated diversification: financial synergies and parenting, the means to achieve diversification.

International Strategy : Creating Value in Global Markets International expansion: a company's motivations and risks, achieving competitive advantage in global markets, entry modes of international expansion

Text Book

1. Strategic Management: Text and Cases, 10th Edition, By Gregory Dess and Gerry McNamara and Alan Eisner and Seung-Hyun Lee, McGrawHill Publications.

Reference Books

1. Strategic Management: Adrian Haberberg and Alison Rieple, Oxford University Press.
2. Strategic Planning & Formulation of Corporate Strategy: V. S. Ramaswami, S. Namaumari, Publication - Macmillan, India.
3. Strategic Management: Anthony Henry, Oxford University Press.
4. Strategic Management and Business Policy: Azhar Kazmi, McGraw Hill Publications.
5. Contemporary Strategy Analysis: Robert Grant, John Wiley Publications.
6. Strategic Management: John A. Pearce II, Richard B. Robinson Jr. and Amita Mital, McGrawHill Publications.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAT802-2 **Course : Digital Manufacturing**

L: 3 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 03**

Course Objectives

The students shall able to :

1. To create, slice, 3D prints parts and post process if required.
2. To understand the subtractive manufacturing and micro fabrication (MEMS).

Course Objectives

Upon successful completion of the course students shall be able to:

CO1 : To understand basic Conventional and Modern Machining Processes and Advanced Materials and their associated properties.

CO2 : Students should able to understand the 2D and 3D Machining operations and Manual CNC Programming.

CO3 : Demonstrate 3D modelling ability using geometric modelling software.

CO4 : Differentiate between subtractive and additive manufacturing methods.

CO5 : Identify the different micro fabrication methods and thin film deposition methods using micro manufacturing methods.

Syllabus

Unit - I : Overview of Digital manufacturing process

Introduction to Digital Manufacturing Science, Operation mode and architecture, Operation reference model, System Architecture, Computation in Digital Manufacturing, case studies.

Unit - II : CNC machines and Programming

Introduction to Numerical Control, Components of NC System, NC system Controls, Adaptive.

Control for NC System, N Words, NC programming, Examples, CNC, DNC combined DNC/CNC system, Computer Integrated manufacturing system, Machine Tools and related Equipment,

Materials handling and Storage system, computer system Tool Path Generation in CAM Software for different operations.

Unit - III : CAD CAM Modelling and Machine Control

Basics of Computer Graphics, Elementary Transformations in CAD, computer programming for graphics, Computer graphics Software and Database: Configuration, Graphics Packages.

Constructing the Geometry, Design process and role of CAD, Types and applications of design models, Solid modelling -Parametric modelling.

Unit - IV : Additive Manufacturing Process

Introduction to Tableau, Creating Basic Visualizations, Tableau Desktop UI, Connecting to Data, Review of Tableau Desktop, Making Visualizations, Creating Effective Dashboards.

Unit - V : Micro-fabrication and Nano-fabrication Methods

Introduction to different methods for manufacturing components by additive manufacturing, Overview of different RP Processes, STL file generation; file verification & repair, STL/AMF Slicing CURA, Pre-processing and post processing techniques.

Text Books

1. "Fundamentals of Digital Manufacturing Science - Zhou, Zude, Xie, Sheng, Chen, Dejun, eBook, Springer publication ISBN 978-0-85729-564-4.
2. Automation, Production System and CIM, Goover, Prentice hall.
3. CAD/CAM/CIM P. Radhakrishnan & Subramanyam, Willey Eastern Limited.
4. Rapid Prototyping Theory and practice - Ali Karmani- Springer.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAP804

Course : Industry Internship-Phase-I / Research Internship-Phase-I / TBI Internship-Phase-I

L: 0 Hrs. T: 0 Hrs. P: 3 Hrs. Per week

Total Credits : 12

Course Objective

To inbuilt the skills in the areas like project management, concept development, planning, implementation, testing and validation while developing robotics and automation applications.

Course Outcomes

The students will able

CO1 : To carry out exhaustive literature review to define the problem.

CO2 : To understand the concept and scope of project work

CO3 : To identify the appropriate Methodology to carry out the project work.

Students opted Industry Internship-Phase-I or Research Internship-Phase-I or TBI Internship-Phase- I can select the appropriate problem in the field of robotics and automation.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAP821 **Course : Dissertation Phase-II**

L: 0 Hrs. T: 0 Hrs. P: 6 Hrs. Per week **Total Credits : 12**

Course Objective

To inbuilt the skills in the areas like project management, concept development, planning, implementation, testing and validation while developing robotics and automation applications.

Course Outcomes

The students will able:

CO1 : To perform kinematics and dynamic analysis of defined problem and to select the suitable drives, actuator and sensors based on application.

CO2 : To decide the appropriate control strategy to perform the task.

CO3 : To apply the tools like ANN, AI to make the system intelligent and autonomous along with to get the proficiency in mathematical and programming tools like MATLAB, ROS.

The M. Tech. Project is aimed to train the students to identify and analyze the research topic independently based on the subject knowledge gained in the previous semesters. The projects should include the problem in the field of robotics and automation applications. The project may be a purely analytical piece of work, a completely experimental or a combination of both. The students should validate the approach used in the project work through testing and experimentation. It is expected to submit the final project report which includes detailed literature review, objective, problem definition, methodology, experimentation, testing, result and conclusion.

Syllabus for Semester - III
M. Tech. (Robotics and Automation)

Course Code : RAP822 **Course : Industry Internship-Phase-II**

L: 0 Hrs. T: 0 Hrs. P: 0 Hrs. Per week **Total Credits : 12**

Course Objective

To inbuilt the skills in the areas like project management, concept development, planning, implementation, testing and validation while developing robotics and automation applications.

Course Outcomes

The students will able

CO1 : To perform kinematics and dynamic analysis of defined problem and to select the suitable drives, actuator and sensors based on application.

CO2 : To decide the appropriate control strategy to perform the task

CO3 : To apply the tools like ANN, AI to make the system intelligent and autonomous along with to get the proficiency in mathematical and programming tools like MATLAB, ROS.

The M. Tech. Project is aimed to train the students to identify and analyze the research topic independently based on the subject knowledge gained in the previous semesters. The projects should include the problem in the field of robotics and automation applications. The project may be a purely analytical piece of work, a completely experimental or a combination of both. The students should validate the approach used in the project work through testing and experimentation. It is expected to submit the final project report which includes detailed literature review, objective, problem definition, methodology, experimentation, testing, result and conclusion.

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