DEPARTMENT OF ROBOTICS AND AUTOMATION

VISION:

To be recognized as a multidisciplinary department and build skilled professionals by imparting quality technical education and inculcating problem solving and lifelong learning skills through project based approach in collaboration with industries in the field of Robotics & Automation.

MISSION:

M1: To impart quality technical education in Robotics and Automation Engineering.
M2: To inculcate sustainable skills in automation technologies, research and learning attitudes, and social responsibilities.
M3: To be committed to fulfill the needs of society in the Robotics & Automation industries.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: Robotics & Automation Engineering graduates excel in solving industrial challenges, innovating for society, and leveraging core engineering principles for industry advancement.
PEO2: Graduates will apply technical expertise, leadership, and entrepreneurship, to establish ethical organizations to address societal needs and pursue higher studies.
PEO3: Graduates will work effectively as individuals and as team members with high ethical values and motivation for life-long learning for the benefit of society.

PROGRAM OUTCOMES (POs):

PO1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Design and Development of robotic systems that are cost effective, environment friendly to solve engineering and societal problems using advanced tools and techniques.

PSO2: Model, program and build an error free, safe, and productive automation systems for various manufacturing processes.

PSO3: Apply domain knowledge of robotics and automation to provide solutions in interdisciplinary areas to meet current industrial challenges.

DEPARTMENT OF ROBOTICS AND AUTOMATION

LIST OF ABBREVIATIONS

Abbreviation	Description
BSC	Basic Science Course
ESC	Engineering Science Course
PCC	Program Core Course
PEC	Program Elective Course
MDM	Multidisciplinary Minor
OE	Open Elective - Other than a particular program
VSEC	Vocational and Skill Enhancement Course
AEC	Ability Enhancement Course
ENTR	Entrepreneurship
EC	Economics
MC	Management Courses
IKS	Indian Knowledge System
VEC	Value Education Courses
RM	Research Methodology
CEP	Community Engagement Project
FP	Field Project
PROJ	Project
INT	Internship
OJT	On Job Training
CC	Co-curricular Courses
HSSM	Humanities Social Science and Management
ELC	Experiential Learning Course
B. Tech	Bachelor of Technology
L	Lecture
P	Practical
T	Tutorial
H	Hours
CR	Credits
CIE	Continuous Internal Evaluation
ETE	End Term Evaluation
TW	Term Work
OR	Oral
PR	Project

DEPARTMENT OF ROBOTICS AND AUTOMATION

Second Year B. Tech. – Robotics & Automation : Semester - III

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)				Evaluation Scheme							
			L	P	T	H	CR			CIE	ETE	TW	PR	OR	Total
							TH	PR/Tut	Total						
RAPC302	PCC	Structural Mechanics for Robotic Applications	3	2	-	5	3	1	4	40	60	-	-	25	125
RAPC303	PCC	Electrical Machines & Drives	3	2	-	5	3	1	4	40	60	-	-	25	125
RAPC304	PCC	Smart Materials & MEMS	2	2	-	4	2	1	3	40	60	-	-	25	125
RAMD301	MDM	Engineering Mathematics III	3	-	-	3	3	-	3	40	60	-	-	-	100
ALOE301	OE	Open Elective – I #	2	-	-	2	2	-	2	40	60	-	-	-	100
RAMC301	HSSM-MC	Project Management System - I	-	2	-	2	-	1	1	-	-	25	-	-	25
RAVS304	VSEC	Problem Solving Technique - I	-	2	-	2	-	1	1	-	-	25	-	-	25
RAVS305	VSEC	Programming in C/C++	-	2	-	2	-	1	1	-	-	-	25	-	25
RACE301	CEP	Project Based Learning	-	2	-	2	-	1	1	-	-	25	-	-	25
RAIN302	ELC - INT	Internship – II	4 Weeks				-	2	2	-	-	25	-	-	25
Total			**13**	**14**	**-**	**27**	**13**	**09**	**22**	**200**	**300**	**100**	**25**	**75**	**700**

 # - Select any one course from the given Open Elective Courses

Course Code	Course Type	Open Elective - I
ALOE301A	OEC	Digital Literacy and Applications
ALOE301B		Environmental Studies
ALOE301C		Green Energy and Sustainability
ALOE301D		Basics of Consumer Electronics
ALOE301E		Renewable Energy Systems

BoS Chairman

ZES's Zeal College of Engineering & Research PU/PN/Engg./285/2007 Narhe, Pune-41

Director
ZES's Zeal College of Engineering & Research Narhe, Pune - 411041.

DEPARTMENT OF ROBOTICS AND AUTOMATION

Second Year B. Tech. – Robotics & Automation: Semester - IV

Course Code	Course Type	Course Name	Teaching Scheme (hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			CIE	ETE	TW	PR	OR	Total
							TH	PR/Tut	Total						
RAPC405	PCC	Robot Kinematics & Dynamics	3	2	-	5	3	1	4	40	60	-	-	25	125
RAPC406	PCC	Sensors & Instrumentation	3	2	-	5	3	1	4	40	60	-	-	25	125
RAPC407	PCC	Advance Manufacturing Technology	2	2	-	4	2	1	3	40	60	-	-	25	125
RAMD402	MDM	Digital Electronics & Microcontrollers	3	2	-	5	3	1	4	40	60	-	25	-	125
ALOE402	OE	Open Elective – II #	2	-	-	2	2	-	2	40	60	-	-	-	100
RAMC402	HSSM-MC	Quality Management System – II	-	2	-	2	-	1	1			25		-	25
RAAE402	AEC	Problem Solving Technique – II	-	2	-	2	-	1	1			25		-	25
RAVS406	VSEC	Python for Robotics	-	2	-	2	-	1	1				25	-	25
RAIN403	ELC - INT	Internship – II	4 Weeks				-	2	2	-	-	25	-	-	25
Total			**13**	**14**	**-**	**27**	**13**	**11**	**22**	**200**	**300**	**75**	**50**	**75**	**700**

# - Select any one course from the given Open Elective Courses		
Course Code	**Course Type**	**Open Elective - II**
ALOE402A	OEC	Cyber Security and Laws
ALOE402B		Sustainability and Climate Change
ALOE402C		Energy Audit and Electrical Safety
ALOE402D		Digital Marketing
ALOE402E		Entrepreneurship and Innovations

BoS Chairman

ZES's Zeal College of Engineering & Research PU/PN/Engg./285/2007 Narhe, Pune-41

Director
ZES's Zeal College of Engineering & Research Narhe, Pune - 411041.

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

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DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

SYLLABUS

SEMESTER - III

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation)							**Semester:** III		
Course: Structural Mechanics for Robotic Applications							**Code:** RAPC302		
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	02	-	04	40	60	-	25	-	125

Prerequisites:

Basic Physics and Mathematics, Engineering Mechanics, Problem-Solving Skills etc.

Course Objectives:

1. To understand the fundamental concepts of stress, strain, and deformation in solid materials.
2. To analyse the behaviour of structural and robotic components under various loading conditions.
3. To develop the ability to design and assess load-bearing elements in robotic systems.
4. To integrate concepts of materials and mechanics in the design of robotic arms, joints, and frames.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain stress-strain concepts and their relevance to robotic structural elements
CO2	Analyze axial, shear and torsional stresses in components of robotic systems
CO3	Compute deformation and design components using Mohr's Circle and strain energy
CO4	Evaluate bending and shear stresses in shaft used in robotic frameworks
CO5	Analyze and determine principal stresses, maximum shear stresses, and their orientations using analytical methods and Mohr's Circle
CO6	Design robotic structural members for stiffness and strength

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Mechanics of Solids:** Concept of stress and strain: axial, shear, bearing stress, and strain, Hooke's Law, Poisson's Ratio, Elastic constants, Stress-strain diagrams for ductile and brittle materials, Importance of material behavior in robotic links and end-effectors.	06
2.	**Axial and Thermal Stress in Robotic Components:** Axial force diagram, stresses, strains, strains & deformations in determinate and indeterminate, homogenous and composite bars under concentrated loads, self-weight and temperature changes. **Application:** Axial loading in robotic frames and actuator mounts, Thermal stress due to actuator heating, Compound bars in robotic chassis.	06

3.	**Bending and Shear in Robotic Arms:** Bending stresses: Theory of simple bending, assumptions, derivation of flexure formula, and second moment of area of common cross sections with respect to centroidal and parallel axes. Shear stresses: Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress. **Application** to robot arms under pick-and-place loading, Section modulus and design optimization.	08
4.	**Torsion in Robotic Shafts and Joints:** Stresses, strains and deformations in determinate and indeterminate shafts of solid and hollow homogeneous and composite circular cross section subjected to twisting moment. Derivation of torsion equation. Stresses due to combined torsion, bending and axial force on shafts. **Application:** Power transmission in robotic drive shafts, Design of torsional robotic joints, Torsional rigidity and angle of twist.	08
5.	**Principal Stresses and Mohr's Circle:** Normal and shear stresses on any oblique plane. Concept of principal planes. Derivation of expressions for principal stresses and maximum shear stress, position of principal planes and planes of maximum shear, graphical solution using Mohr's circle of stresses. **Application** to robotic grippers and linkages	07
6.	**Deflection and Strain Energy in Robot Structures:** Relation between BM and slope, slope and deflection of determinate beams, Double Integration Method (Macaulay's Method). Derivation of Formulae for Slope and Deflection for Standard Cases. **Applications:** Analysis of robotic end-effector deflection under load.	07
	TOTAL	**42**

List of Experiments:

Students have to perform any 8 experiments in workshop/laboratory related to following topics

1. Tension Test on Mild Steel Specimen using UTM
2. Torsion Test on Mild Steel or Aluminium Shaft
3. Compression Test on Robotic Gripper Material (e.g., Rubber or Soft Polymer)
4. Shear Test on Metallic Specimen
5. Bending Test on Beam (Cantilever/Simple Support)
6. Deflection of Beam by Load (using dial gauge or displacement sensor)
7. Determination of Stress Concentration using Photo Elasticity Kit or FEM Simulation
8. Stress and Deflection analysis of Simply Supported beam using ANSYS.
9. To draw Shear stress and bending moment diagram for a Beam using ANSYS**.**
10. Stress and Deflection Analysis of Column using ANSYS

Text Books:
1. Timoshenko and Gere, "Mechanics of Materials", McGraw Hill 2. R.K. Bansal, "Strength of Materials", Laxmi Publications 3. Ferdinand Beer & E. Russell Johnston, "Mechanics of Materials", McGraw Hill
Reference Books:
1. Gere & Goodno, "Mechanics of Materials", Cengage Learning 2. J.P. Den Hartog, "Strength of Materials", Dover Publications 3. S.S. Rattan, "Strength of Materials", McGraw Hill
E-Resources:
1. https://onlinecourses.nptel.ac.in/noc25_me107/preview 2. https://ocw.mit.edu/courses/2-080j-structural-mechanics-fall-2013/ 3. https://nitsri.ac.in/Department/Mechanical%20Engineering 4. https://sist.sathyabama.ac.in/sist_coursematerial/uploads 5. https://www.youtube.com/watch?v=aQf6Q8t1FQE&list=PLEYqyyrm-hQ3wtF34smyJSAOqUJqnf1ch – Strength of Materials by The Efficient Engineers 6. https://www.youtube.com/playlist?list=PL9RcWoqXmzaLlfmNg2Ku1SdZtvXnYrLbc 7. https://www.youtube.com/playlist?list=PL1LjPgjWt_IYJxqopL3fDi4bvI0f48RHK

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation)									**Semester:** III
Course: Electrical Machines and Drives									**Code:** RAPC303
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	02	-	04	40	60	-	25	-	125

Prerequisites:

1. Fundamentals of Electrical Engineering.
2. Basic Electronics Engineering or Fundamentals of Electronics Engineering.

Course Objectives:

1. To study principle of operation of DC machines, it's braking and speed control methods.
2. To know about three phase induction motor working, speed control methods and its applications.
3. To study the working principle of single phase induction motors.
4. To understand the working principle of special purpose motors and their applications.
5. To get familiar with various electrical drives and their uses.
6. To understand the operation and performance of DC drives.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand the operation of DC motor, its speed control methods and braking.
CO2	Distinguish between types of three phase induction motor and its characteristic features and speed control methods.
CO3	Develop the capability to identify and select suitable Single phase induction motor for given industrial application.
CO4	Develop the capability to identify and select suitable Special Purpose motor for given industrial application.
CO5	Understand the basics of electric drives and fundamentals of drive dynamics.
CO6	Understand the operation of DC motor drives and their applications.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**D.C. Motors and its Control:** Principles of working, Significance of back EMF, (Simple numerical on particular topics) Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control methods of DC Motor, Braking in DC motor and its types.(Brief Explanation)	07
2.	**Three Phase Induction Motor:** Types of induction motor, torque and power output, (Simple numerical on particular topics) starting methods, speed control, induction generator, starters (DOL starter and Star Delta starter), Methods of speed control- voltage and frequency control, variable frequency drive, applications.	07

3.	**Special Purpose Motors – Part 1:** Single phase induction motors, (types, construction, working principle of split phase and shaded pole type induction motors), descriptive treatment for AC series motor (difference between AC series and DC series motor, construction and working) and their Applications	07
4.	**Special Purpose Motors – Part 2:** Construction, working principle, characteristic and applications of stepper motors drives, A.C. and D.C servomotor drives, Universal motors, BLDC motors, PMDC motors, industrial applications, Linear induction motors and their Applications.	07
5.	**Electric Drives, Dynamics and Control:** Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, drive classifications, Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components. Nature and classification of Load Torques and selection motors.	07
6.	**Motor Drives and its Applications:** DC motors and their performance starting, transient analysis, ward Leonard drives, Controlled rectifier fed drives, full controlled 3 phase rectifier control of dc separately excited motor, multi-quadrant operation, Chopper controlled drives Closed loop speed control of motor, applications of motor drives.	07
	TOTAL	**42**

List of Experiments:

1. Demonstration of use of starters for DC motor and three phase induction motor along with understanding of specifications on name plates of these machines.
2. Brake test on DC shunt motor.
3. Study of power electronic converter based DC motor drive
4. Study of electrical braking of DC shunt motor (Rheostatic/ Plugging/regenerative)
5. Load test on three phase induction motor.
6. Torque- speed characteristics of three phase induction motor.
7. Study of BLDC Motor and its components
8. Study of Servo Motor and its components.

Assign following experiments by applying Virtual Labs:

9. Speed control of DC shunt motor by armature and field resistance control.
10. Speed control of slip ring induction motor by rotor resistance control.

Please refer http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html

11. Industrial Visit to a DC Motor/ Generator/ Induction Motor/ Electric Drive Unit/Company.

Text Books:

1. Hughes Edward, "Electrical and Electronic Technology", Pearson Education
2. Ashfaq Husain, "Electric Machines", 3rd Ed, Dhanpat Rai & Sons

3. Bhattacharya S. K., "Electrical Machine", 3rd Ed, Tata McGraw Hill
4. Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill
5. P. C. Sen, "Principles of Electric Machines and Power Electronics ", John Wiley and Sons Publication, second edition 1997.
6. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.

Reference Books:

1. Lowe, "Electrical Machines", Nelson Publications
2. Pillai S. K., "A First Course on Electrical Drives", New Age International (P) Ltd.
3. M. H. Rashid, "Power Electronics -Circuits, devices and Applications", 3rd Edition, PHI Pub. 2004.
4. G. K. Dubey, "Fundamentals of Electrical Drives", Second edition (sixth reprint), Narosa Publishing house, 2001.
5. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc25_ee124/preview (for e-learning courses and video lectures)
2. https://www.youtube.com/watch?v=6DctdwlDKhc
3. https://nptel.ac.in/courses/108104140
4. https://www.youtube.com/watch?v=Ub-csHc4VhA

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation)								**Semester:** III	
Course: Smart Materials & MEMS								**Code:** RAPC304	
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	02	-	03	40	60	-	25	-	125

Prerequisites:

Physics, Chemistry, Basic Electronics or Electrical Circuits etc

Course Objectives:

1. To understand the fundamentals of crystal structures.
2. To understand working principles and unique properties of each smart material type.
3. To understand the fundamental behaviors of Shape Memory Alloys
4. To equip the knowledge of polymer and composite materials used in robotics
5. To understand the MEMS technology, including materials, fabrication techniques, and applications of MEMS sensors and actuators in robotics.
6. To introduce the integration of MEMS and smart materials, exploring their applications in advanced robotics.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain and differentiate between crystal structures and describe lattice parameters and Miller indices.
CO2	Explain the general working principles behind the actuation or sensing behavior of each type of smart material.
CO3	Describe phase transformation and pseudo-elastic behavior of SMAs and explain their actuation capabilities
CO4	Students will be able to analyze and select appropriate polymer and composite materials for specific robotic components
CO5	Explain the MEMS scaling laws, identify suitable materials and fabrication processes, and design or select MEMS sensors and actuators for robotic applications.
CO6	Students will be able to analyze and evaluate the role of integrated smart materials and MEMS

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Engineering Materials & Material Characteristics:** **Crystal Structures:** Study of Crystal structures BCC, FCC, HCP and lattice parameters & properties, Miller indices, Crystal imperfections, and Diffusion Mechanisms. **Material Properties:** Mechanical (Impact, hardness, etc.), Electrical, optical and Magnetic Properties **Fracture:** Types factures (brittle, ductile) Creep & Fatigue failures. **Selection of materials** for robotic frames, gears, links, and end-effectors, Limitations and challenges with conventional materials in robotics.	05

2.	**Introduction to Smart Materials:** Types and classification of smart materials, Piezoelectric, Shape Memory Alloys (SMA), Electro-Rheological (ER) fluids, Magneto-Rheological (MR) fluids, Electroactive Polymers (EAP), General working principles, advantages over conventional materials. Applications in robotics: sensors, actuators, adaptive components.	04
3.	**Behavior and Applications of Smart Materials:** **Shape Memory Alloys**: Phase transformation, pseudo elasticity, actuation, **Piezoelectric materials**: Direct/inverse effects, sensing, and actuation, **Magnetostrictive materials**: Working principle, robotic applications, **ER/MR Fluids**: Viscosity control, adaptive damping, robotic suspension, Application-focused case studies in soft robotics, micro grippers, precision actuators	05
4.	**Polymer and Composite Materials in Robotics:** Polymers: ABS, Nylon, PTFE, etc. used in flexible and lightweight robots**,** Selection criteria of polymer material for robots. **Composites:** Carbon-fiber reinforced plastics (CFRP), Glass-fiber composites**.** Use in humanoid shells, prosthetics, drone arms, and structural frames**,** Thermal, corrosion and wear considerations**,** Emerging biodegradable and sustainable materials in robotics.	05
5.	**Micro-Electro-Mechanical Systems (MEMS):** Introduction to MEMS: Scaling laws and microsystem relevance, **Materials for MEMS:** Silicon, polymers, metals, **MEMS fabrication**: Photolithography, etching, deposition, packaging, **MEMS sensors in robotics:** accelerometers, gyros, tactile sensors, MEMS actuators: Electrostatic, thermal, piezo-based.	05
6.	**Integration and Future of Smart Materials and MEMS:** **MEMS + Smart Material integration:** Artificial muscles, micro fluidics, Smart composites for embedded sensing and actuation, Role in bio-inspired robotics, medical robotics, and wearables, Industry 4.0 and IoT-enabled smart materials. **Future trends:** Nanomaterial's, flexible electronics, bio-MEMS.	04
	TOTAL	**28**

List of Experiments:

Students have to perform any 8 experiments in workshop/laboratory related to following topics

1. Study of Crystal Structures (BCC, FCC, HCP) using Crystal Models and Simulation Tools
2. Hardness Test on Metals and Polymers (Brinell, Rockwell, or Vickers)
3. Impact Test (Charpy or Izod) on Robotic Frame Materials (Aluminum, CFRP, etc.)
4. Demonstration of Shape Memory Alloy (SMA) Actuation
5. Piezoelectric Sensor and Actuator Demonstration
6. Material Selection Case Study using Ashby Charts (Polymers vs Composites)
7. Microscopic Study of Composite Materials (CFRP, GFRP)

8. Study and Testing of MEMS Accelerometers and Gyroscopes
9. Integration of Piezo/MEMS Sensor in a Soft Robotic Gripper
10. Case Study Presentation/Simulation: MEMS + Smart Materials for Bio-inspired Robotics

Text Books:

1. Vijay K. Varadan et al., "Smart Material Systems and MEMS", Wiley.
2. N.P. Mahalik, "*MEMS"*, Tata McGraw-Hill.
3. M. Addington and D. Schodek, "Smart Materials and Technologies", Elsevier
4. Agrawal B.K., "Introduction to Engineering Metallurgy, Forming and welding", Tata McGraw-hill publishing, 2006.
5. Kodgire V. D., "Material science and metallurgy for Engineers", Everest Publishing House, Pune.
6. K. G. Bundinski, M. K. Bundinski, "Engineering Materials" Prentice Hall of India Pvt. Ltd., New- Delhi.
7. Smith W. F., "Principles of Material Science and Engineering", McGraw- Hill Inc. Book Company.

Reference Books:

1. Rollason E. C., "Metallurgy for Engineering", ELBS Publishing.
2. Tai-Ran Hsu, "MEMS and Microsystems", McGraw-Hil
3. William D. Callister, "Materials Science and Engineering", Wiley
4. Clark D.S.and Vamey W. R. "Physical Metallurgy for Engineers", East-West Press Pvt. Ltd., New Delhi.
5. Donald R. Askeland & Pradeep Phule. , "The science and engineering of materials", Thomson Asia Pvt. Ltd.

E-Resources:

1. https://crridom.gov.in/open-access-e-resources
2. https://library.iitbbs.ac.in/e-resources
3. https://ess.inflibnet.ac.in/journals.php
4. https://ieeexplore.ieee.org/
5. https://onlinecourses.swayam2.ac.in/nou25_mm03/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation Engineering)							**Semester:** III		
Course: Engineering Mathematics – III							**Code:** RAMD301		
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Differential and Integral calculus, Differential equations of first order and first degree, Fourier series, Collection, classification and representation of data, Permutations & combinations and Vector algebra, Vector Differentiation.

Course Objectives:

To make the students familiarize with concepts and techniques in Ordinary & Partial differential equations, Laplace transform & Fourier transform, Statistical methods, Probability theory and Vector calculus. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes: After completion of this course, students will be able to -

CO1	Solve higher order linear differential equations and its applications to model and analyze mass spring systems.
CO2	Apply Laplace transform to analyze control systems in robotics and automation
CO3	Apply Fourier Transform techniques to analyze and interpret signals in robotics and automation systems.
CO4	Analyze data using concepts of statistics and probability.
CO5	Apply the knowledge of vector integral calculus to solve the fluid flow problems.
CO6	Solve Partial differential equations such as wave equation, one- and two-dimensional heat flow equations.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Linear Differential Equations:** Linear Differential Equations (LDE) of nth order with constant coefficients, Method of variation of parameters, Cauchy's and Legendre's D.E., Simultaneous DE and Symmetric DE, Applications of differential equations in mass spring systems.	08
2.	**Laplace Transforms:** Definition and properties of Laplace transform, Inverse Laplace transform, Applications of Laplace transform to solve differential equation.	06
3.	**Fourier Transforms:** Fourier Transform (FT): Fourier integral theorem, Fourier transform, Fourier Sine & Cosine transform, Inverse Fourier Transforms.	07

4.	**Statistics & Probability:** Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis, Correlation and Regression analysis Definition and theorems on Probability, Probability distributions: Binomial, Poisson, Normal. Test of Hypothesis, Chi Square Test.	07
5.	**Vector Integral Calculus:** Line integral, work done, Green's Lemma, Gauss's Divergence theorem and Stokes's theorem.	07
6.	**Partial Differential Equations (PDE) and Applications:** Partial Differential Equations (PDE), Solution of PDE, modeling and solution of Vibrating String, One- and Two-dimensional Heat flow problems.	07
	TOTAL	**42**

Text Books:

1. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publications, Delhi.
3. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics, Volumes I and II", Pune Vidyarthi Griha Prakashan, Pune.

Reference Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India.
2. M. D. Greenberg, "Advanced Engineering Mathematics, 2e", Pearson Education.
3. Peter V. O'Neil, "Advanced Engineering Mathematics, 7e", Cengage Learning.
4. S. L. Ross, "Differential Equations, 3e", Wiley India.
5. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists, 5e", Elsevier Academic Press.
6. S. J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover Publications, 1993.

E-Resources:

1. NPTEL Course - https://nptel.ac.in/courses/111/105/111105123/
2. NPTEL Course "Probability Theory and Applications", https://nptel.ac.in/courses/111/104/111104079/

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: (Robotics and Automation Engineering)						**Semester:** III			
Course: Project Management System – I						**Code:** RAMC301			
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	-	-	25

Prerequisites:

Interactive mind-set for practical.

Course Objectives:

1. To acquire basic knowledge of Problem-solving techniques.
2. Understanding the structured way of solving problems with the right tools.

Course Outcomes: After completion of this course, students will be able to -

CO1	Know the project and its importance.
CO2	Understand the structured way of project execution process.
CO3	Understand on how to project, goals and timeline.
CO4	Know the key principles of project management.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Project & Management System:** What is a project, What is Project Management, Types, Importance and its benefits.	06
2.	**Project Management Process:** Planning, Execution, Monitoring & Control, Deliverables, Stakeholders.	06
3.	**Principles:** 12 Principles of Project Management.	16
	TOTAL	**28**

Text Books:

1. K. Nagarajan, "Project Management", New Age International Publishers.
2. Joseph Heagney**,** "Fundamentals of Project Management", AMACOM.
3. Harold Kerzner**,** "Project Management: A Systems Approach to Planning, Scheduling, and Controlling", Wiley.

Reference Books:

1. "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", Project Management Institute.
2. BB Goel, "Project Management: Principles and Techniques", Deep & Deep Publications Pvt. Ltd.

E-Resources:

1. Dr. Nimisha Singh, "Introduction to Project Management: Principles & Practices", NPTEL Course - https://onlinecourses.swayam2.ac.in/imb25_mg167/preview
2. Prof. Raghu Nandan Sengupta, "Project Management", NPTEL Course - https://onlinecourses.nptel.ac.in/noc25_mg78/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: (Robotics and Automation Engineering)								**Semester:** III	
Course: Problem Solving Techniques – I								**Code:** RAVS304	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	-	-	25

Prerequisites:

Interactive mind-set for practical.

Course Objectives:

1. To acquire basic knowledge of Problem-solving techniques.
2. To understand the structured way of solving problems with the right tools.

Course Outcomes: After completion of this course, students will be able to -

CO1	Know the problem and types of problem.
CO2	Understand the structured way of solving a problem.
CO3	Understand the basic tools and its application.
CO4	Apply the learning to solve simple problem cases as a team.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Problem Understanding:** Define problem, Types of Problem, What is problem solving? Structured way of Problem solving – Step by Step.	06
2.	**Problem Solving Approach:** Structured step by step working model, Principles to think and apply.	06
3.	**Basic Tools for Problem Solving:** Knowing the tools and applying the right tools at the right step of problem solving, Problem solving case study.	16
	TOTAL	**28**

Text Books:

1. M.T. Somashekara, "Problem Solving and Programming Concepts", PHI Learning.
2. Dheeraj Sharma, "Problem Solving and Decision Making", McGraw-Hill Education.

Reference Books:

1. Willian Henderson, "Master Critical Thinking, Creative, Logic & Problem solving skills", Peak Publish LLC.
2. Sharma Narender, "Handbook 7 QC tools", Shakehand with Life.

E-Resources:

1. Coursera: "Creative Problem Solving" - https://www.coursera.org/learn/creative-problem-solving.
2. MindTools – "Problem Solving Techniques", https://www.mindtools.com/cx4ems0/problem-solving.

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)							**Semester:** III		
Course: Programming in C/C++							**Code:** RAVS305		
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	-	25	25

Prerequisites:

No prior programming experience required, basic electronics and logic gates

Course Objectives:

1. To introduce the fundamentals of C/C++ programming
2. To develop algorithmic and logical thinking
3. To apply C/C++ for solving robotics-related problems
4. To build a foundation for microcontroller programming and embedded systems

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand the history, structure, and development environment setup for C/C++ programming with Logic Building
CO2	Declare variables and apply appropriate data types in C/C++; perform input/output operations using
CO3	Write structured programs using operators, conditional statements, and loops; define and invoke user-defined functions for modularity.
CO4	Organize data using arrays, manipulate strings, define structures, and use pointers for memory referencing in robotic applications.
CO5	Implement file operations to read, write, and store sensor-related data in external files for robotic data logging.
CO6	Simulate basic robotic behaviors such as line follows and obstacle detection using decision-making logic and sensor data processing.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to C/C++ with logic building in Robotics**: History, IDE setup (TurboC++, Code::Blocks), structure of C/C++ program	06
2.	**Variables, Data Types, and I/O in Sensor Control**: Integer, float, char, string, input/output using scanf & printf	05
3.	**Operators and Control Flow in Robotic Decisions:** Arithmetic, logical, relational operators; if, switch, nested conditions **Loops and Functions**: for, while, do-while, recursion, function declaration and call	05
4.	**Arrays, Strings, Structures & Pointers for Robotic Data Handling**: Single & multidimensional arrays, character arrays, string functions **Structures and Pointers**: User-defined types, pointer basics, pointer with arrays & functions	05

5.	**File Handling for Robotic Data Logging**: Opening, reading, writing, closing files – used in logging sensor data	02
6.	**Practical Applications in Robotics**: Simulate line following logic, basic obstacle detection, command processing	05
	TOTAL	**28**

List of Experiments:

1. Display "Hello, Robotics!" with Student Name Input
2. Arithmetic Operations on Sensor Data
3. Sensor Threshold Logic Using if-else
4. PWM Pulse Simulation using for Loop
5. Average Sensor Reading Using Function & Array
6. Switch-Case to Simulate Robot Modes (Idle, Active, Error)
7. Command Parsing: String Manipulation for "START", "STOP"
8. Structure to Hold Robot Sensor Data with Status
9. Pointer with Array: Sensor Data Access by Reference
10. File Handling: Log Sensor Readings into a Text File
11. Simulate LED Blinking using Loops and Delay Logic
12. Case Study: Simulate Line-Following Robot Logic

Text Books:

1. E. Balagurusamy, "Programming in ANSI C", McGraw-Hill.
2. Yashavant Kanetkar, "Let Us C", BPB Publications.
3. Bjarne Stroustrup, "Programming — Principles and Practice Using C++", Addison-Wesley.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Prentice Hall.
2. Robert Lafore, "Object-Oriented Programming in C++", SAMS.
3. S. R. Schach, "Introduction to Object-Oriented Programming with C++", McGraw-Hill.

E-Resources:

1. https://www.geeksforgeeks.org/c/c-programming-language/
2. https://www.w3schools.com/cpp/
3. https://www.learncpp.com/
4. https://onlinecourses.nptel.ac.in/noc25_cs119/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)									**Semester:** III
Course: Project Based Learning									**Code:** RACE301
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	-	-	25

Prerequisites: Fundamental Knowledge of Engineering, Communication skill, Team work & Collaboration

Preamble:

For better learning experience, along with traditional classroom teaching and laboratory learning; project based learning has been introduced with an objective to motivate students to learn by working in group cooperatively to solve a problem.

Project-based learning (PBL) is a student-centric pedagogy that involves a dynamic classroom approach in which it is believed that students acquire a deeper knowledge through active exploration of real-world challenges and problems. Students learn about a subject by working for an extended period of time to investigate and respond to a complex question, challenge, or problem. It is a style of active learning and inquiry-based learning.

Problem based learning will also redefine the role of teacher as mentor in learning process. Along with communicating knowledge to students, often in a lecture setting, the teacher will also to act as an initiator and facilitator in the collaborative process of knowledge transfer and development.

Course Outcomes: After completion of this course, students will be able to -

CO 1	Project based learning will increase their capacity and learning through shared cognition.
CO 2	Students able to draw on lessons from several disciplines and apply them in practical way.
CO 3	Learning by doing approach in PBL will promote long-term retention of material and replicable skill, as well as improve teachers' and students' attitudes towards learning.

Group Structure:

Working in supervisor/mentor – monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

- There should be team/group of 5 -6 students
- A supervisor/mentor teacher assigned to individual groups

Selection of Project/ Problem:

The problem-based project oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. Students design and analyse the problem within an articulated interdisciplinary or subject frame.

A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students' wondering within different disciplines and professional environments. A chosen problem has to be exemplary. The problem may involve an interdisciplinary approach in both the analysis and solving phases. By exemplarity, a problem needs to refer back to a particular practical, scientific, social and/or technical domain.

The problem should stand as one specific example or manifestation of more general learning outcomes

related to knowledge and/or modes of inquiry. There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content
and structure of the activity.

- A few hands-on activities that may or may not be multidisciplinary
- Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize and present their learning.
- Activities may include- Solving real life problem, investigation /study and Writing reports of in depth study, field work.

Assessment:

The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness. Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary.

During process of monitoring and continuous assessment AND evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor/mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services.

Supervisor/mentor and Students must actively participate in assessment and evaluation processes. Group may demonstrate their knowledge and skills by developing a public product and/or report and/or presentation.

- Individual assessment for each student (Understanding individual capacity, role and involvement in the project)
- Group assessment (roles defined, distribution of work, intra-team communication and togetherness)
- Documentation and presentation

Evaluation and Continuous Assessment:

It is recommended that the all activities are to be record and regularly, regular assessment of work to be done and proper documents are to be maintained at college end by both students as well as mentor (you may call it PBL work book).

Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department and institutes.

Recommended parameters for assessment, evaluation and weightage:

- Idea Inception (5%)
- Outcomes of PBL/ Prob`lem Solving Skills/ Solution provided/ Final product (50%) (Individual assessment and team assessment)
- Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents) (25%)
- Demonstration (Presentation, User Interface, Usability etc) (10%)
- Contest Participation/ publication (5%)

- Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects (5%)

PBL workbook will serve the purpose and facilitate the job of students, mentorand project coordinator. This workbook will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken.

References:

- Project-Based Learning, Edutopia, March 14, 2016.
- What is PBL? Buck Institute for Education.
- www.schoology.com
- www.howstuffworks.com

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)								**Semester:** III	
Course: Internship – II								**Code:** RAIN302	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	-	-	02	-	-	25	-	-	25

Preamble:

Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.

Course Objectives:

1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry.
2. Learn to implement the technical knowledge in real industrial situations.

Course Outcomes: After completion of this course, students will be able to -

CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.

Internship Requirements

1. **Internship Duration:** It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 4 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW).
2. **Internship Opportunities:** Students can explore various opportunities for internships at:
    a. Industries
    b. Research labs or organizations
    c. Collegiate clubs
    d. In-house research projects
    e. Online internships
3. **Support and Assistance:** Students can seek assistance for securing internships from:
    a. The Training and Placement cell, along with departmental coordinators
    b. Department or institute faculty members
    c. Personal contacts
    d. Directly connecting with industries or organizations
4. **Request Letter:** Once an industry, research organization, or collegiate club is identified,

students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

SYLLABUS

SEMESTER - IV

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation Engineering)							**Semester:** IV		
Course: Robot Kinematics & Dynamics							**Code:** RAPC405		
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	02	-	04	40	60	-	25	-	125

Prerequisites:

Engineering Physics, Engineering Mathematics, Engineering Mechanics

Course Objectives:

1. Select the type of mechanism for the robotic applications
2. Perform kinematic analysis, synthesis of mechanisms.
3. Perform forward and inverse kinematics of robots
4. Apply design procedure for mechanical grippers depending upon their types and mechanism
5. Design of robot manipulators based on dynamic analysis
6. Understand angular velocity and velocity kinematics in robotic systems.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand and analyze basic mechanisms and kinematic chains.
CO2	Analyze velocity and acceleration in mechanisms using kinematic methods.
CO3	Apply principles of rotation and motion kinematics.
CO4	Analyze robot kinematic chains using standard conventions
CO5	Solve forward and inverse kinematics problems in robotic systems.
CO6	Analyze angular and velocity kinematics of rigid robotic links.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Robot Mechanisms:** Kinematic Link, Types of links, Kinematics pair, Types of constrained motion, Classification of Kinematics pairs, Kinematics chain, Degrees of freedom of mechanisms, Inversion of mechanism, Analysis of mechanisms such as Gear trains, cams and followers, belt drives, four bar mechanism, slider crank mechanism etc. Computer aided analysis and synthesis of coupler curves for four bar/five bar mechanism and slider crank mechanisms.	08
2.	**Forward Kinematics:** Robot kinematics-Types- 2D, 3D Transformation, D-H Representation, Displacement Matrices for Standard Configurations, Forward kinematics of manipulators up to 6 degrees of freedom.	05
3.	**Inverse Kinematics:** Inverse kinematics analysis of robot with standard configurations, methods for solution of non-linear simultaneous equations, use of meta-heuristics for inverse	07

	kinematic solutions.	
4.	**Robot End Effectors:** Types of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive grippers, tools. Force analysis, the robot end effectors interface, considerations in gripper selection and design.	07
5.	**Robot Arm Dynamics:** Robot dynamics – Rigid body dynamics, Newton-Euler formation, Lagrange-Euler, formation, generalized D'Alembert equations of motion, Simulation using dynamics equations.	08
6.	**Motion Control and Trajectory Planning :** Joint space and task space trajectory generation, Cubic and quintic polynomial interpolation, Real-time motion planning basics, Introduction to dynamics-based control (Feed forward control), Simulating dynamics using MATLAB/Simulink or Python	07
	TOTAL	**42**

List of Experiments:

1. Study of Kinematic Links, Pairs and Robotic Joint system using models on each.
2. Demonstration of Four Bar Mechanisms.
3. Velocity and Acceleration Analysis of a Robotic System.
4. Find the DH Parameter for a particular joint configuration and number manipulators.
5. Experiment on Robot forward kinematic analysis using simulation software like RoboAnalyzer, RobotDK, CoppeliaSim and etc.
6. Experiment on Robot inverse kinematic analysis using simulation software like RoboAnalyzer, RobotDK, CoppeliaSim and etc.

Text Books:

1. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co.
2. Ratan S. S.,"Theory of Machines", Tata McGraw HillEducation.
3. Bansal R.K., "Textbook of Theory of Machines", Laxmi publications.
4. Deb S.R., "Robotics", Tata McGraw Hill Publications, New Delhi.
5. Balaney, "Theory of Machines", Khanna Publications.

Reference Books:

1. Reza N. Jazar, "Theory of Applied Robotics, 2ed.", Springer.
2. Bruyninckx H., "Robot Kinematics and Dynamics", Katholieke Universiteit Leuven
3. T. Beven,Theory of Machines, Pearson Education, India.
4. Joseph E Shigley and John Uicker, Theory of Machines, McGrawHill.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc25_me164/preview
2. https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/
3. https://petercorke.com/toolboxes/robotics-toolbox/

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)								**Semester:** IV	
Course: Sensors & Instrumentation								**Code:** RAPC406	
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	02	-	03	40	60	-	25	-	125

Prerequisites:

Basic Electrical Engineering, Basic Electronics Engineering, Physics, Engineering Mathematics

Course Objectives:

1. Familiarity with sensor principles and Technologies
2. Master Sensor interfacing and signal conditioning
3. Explore Sensor Fusion and Integration
4. Examine Applications of Sensor Technology
5. 5. Explore Emerging Trends and Future Directions

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand and analyze the fundamental concepts of measurement systems.
CO2	Understand the role of sensors in various robotic applications such as industrial automation, autonomous navigation, and manipulation tasks.
CO3	Understand and apply the working principles and characteristics of motion, proximity, and temperature sensors
CO4	Analyze sensor data to evaluate the performance and reliability of sensors in specific robotic tasks and environments (Force, Torque etc.)
CO5	Understand the role of Intelligent Instrumentation and Acquisition Systems
CO6	Understand and analyze recent advancements in sensor technologies for robotic

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Measurement & Sensors:** Basics of measurement systems, Definition of sensor and transducer, Types of errors and error analysis, Static and dynamic characteristics of transducers, Sensor classification and calibration techniques, Sensor output signal types.	07
2.	**Robot Sensors:** Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors - Photo Electric Sensors, Position sensors – Piezo Electric Sensor. Resolvers, Encoders – Absolute and Incremental: - Optical, Magnetic, Capacitive, Pneumatic position sensors.	08
3.	**Motion, Proximity & Temperature Sensors:** Potentiometers, encoders, resolvers, Inductive, capacitive, magnetic sensors, LVDT, RVDT, accelerometers, GPS, Bluetooth, ultrasonic, light detector and ranging (LIDAR)	07

	Definition of Temperature: Thermal Energy, absolute and relative Temperature, Resistance-Temperature Detectors (RTD), Thermistors, Thermistor Characteristics, thermocouples, Thermoelectric Effects, Characteristics, Thermocouple Sensors, seebeck effect and peltier effect.	
4.	**Force, Torque, and Tactile Sensors:** Strain gauge principles and Wheatstone bridge, Load cells, piezoelectric force sensors, Tactile sensors and slip detection, Torque measurement for robotic manipulators, Gripper and end-effector sensor integration.	06
5.	**Instrumentation Systems and Data Acquisition:** Block diagram of instrumentation system, Signal conversion: ADC, DAC, sampling, and quantization, Data acquisition systems (DAQ), multiplexing, Noise reduction and grounding techniques. Interfacing sensors with microcontrollers (e.g., Arduino, Raspberry Pi).	07
6.	**Advancement in Sensors for Robotics:** Flexible and Wearable Sensors- Printed electronics and soft robotics integration **Types**: Stretchable strain sensors, e-skin (electronic skin), tactile fabrics, Bio-Inspired Sensors - Mimicking human/animal sensory systems, **Types**: Artificial retina, Bio-mimetic tactile sensors, Olfactory (gas) sensors mimicking smell, AI-Enabled Sensors (Edge AI) -Sensors with AI/ML algorithms embedded for real-time decision-making at the edge, Supports deep learning inference, Examples: Google Coral, NVIDIA Jetson, EdgeTPU-based sensors Wireless and IoT-Enabled Sensors - Wireless protocols (ZigBee, BLE, LoRa, Wi-Fi 6), Cloud-based data logging.	07
	TOTAL	**42**

List of Experiments:

Students have to perform any 8 experiments in laboratory related to following topics

1. Study of Measurement System Components
2. Measurement of speed and displacement using linear sensors
3. Position Sensing Using Potentiometer and Encoder
4. Proximity Sensing Using Inductive and Capacitive Sensors
5. Measurement of temperature using thermistor (whetstone Bridge)
6. Study of photo sensors.
7. Temperature Measurement Using Thermocouple & RTD
8. Force Measurement Using Strain Gauge and Load Cell
9. Vibration and acceleration measurements using piezo electric sensor.
10. Study on data acquisition systems and interfacing sensors with computer

Text Books:

1. Sawhney A. K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 4th Edition, 1994.

2. D. Patranabis, "Sensors and Transducers", Prentice Hall India Learning Private Limited, 2nd Edition.
3. Ernest. O. Doebelin, Danish N. Manik, "Measurement Systems", 2019, 7th Edition, McGraw Hill Book co.

Reference Books:

1. Andrzej M. Pawlak, "Sensors and Actuators in Mechatronics: Design and Applications", CRC Press.
2. Ricardo Suárez Fernández, "Fundamentals of Industrial Automation".
3. B. C. Nakra and K. K. Chaudhary, "Instrumentation, Measurement and Analysis", McGraw Hill Education India Private Limited, 4th Edition.
4. John G. Webster, "Instrumentation and Sensors Handbook", CRC Press, 1st Edition, 1999.
5. D. V. S. Murty, "Transducers and Instrumentation", PHI Learning Pvt. Ltd., 2010.
6. D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill, Third Edition.
7. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall International Edition, 6th Edition.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee105/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee108/preview
3. https://www.youtube.com/watch?v=X55ecl8nky4&list=PLp6ek2hDcoNBrYuh8TYc3YNQUvKanqiRa&index=3
4. https://onlinecourses.nptel.ac.in/noc23_ee105/preview
5. https://nptel.ac.in/courses/108105064
6. https://onlinecourses.nptel.ac.in/noc25_ee76/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation Engineering)				**Semester:** IV					
Course: Advance Manufacturing Technology.				**Code:** RAPC407					
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	02	-	03	40	60	-	25	-	125

Prerequisites:

Physics, Chemistry, Engineering materials, Smart materials Strength of material.

Course Objectives:

1. To provide a comprehensive understanding of both conventional and advanced manufacturing processes.
2. To connect manufacturing principles to the design and fabrication of robotic components and systems.
3. To enable students to evaluate and choose appropriate manufacturing processes for robotic applications.
4. To expose learners to modern trends including CNC, Additive Manufacturing, Automation, and Industry 5.0.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain and differentiate conventional and modern manufacturing processes for robotic components.
CO2	Apply forming, casting, and machining techniques to fabricate robot links and frames.
CO3	Analyze and select non-traditional processes for complex parts such as robotic joints or grippers.
CO4	Integrate CAD/CAM and CNC for robot part manufacturing.
CO5	Evaluate additive and hybrid manufacturing for rapid prototyping and customization in robotics.
CO6	Illustrate automation strategies and Industry 5.0 tools applied in intelligent robotic manufacturing.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Casting and Forming Techniques in Robotic Fabrication:** Overview of Casting: Sand casting, Die casting, Investment casting, Applications in robot base, housing, and structural components, Metal Forming Processes: Forging, Rolling, Extrusion, Deep Drawing, Sheet metal forming for robot body and enclosures, Process selection based on strength, accuracy, and weight	05
2.	**Machining and Welding for Robotic Structures:** Conventional Machining Processes: Lathe, Milling, Drilling, Grinding, Surface finishing and tolerance control for robotic assemblies, Welding Techniques: Arc welding, MIG/TIG welding, Laser welding, Weld joints in robotic arm segments, actuator housings, Automation in machining and welding (robot-assisted)	05

3.	**Non-Traditional Machining for Complex Robotic Components:** Need for non-traditional methods in miniaturized/micro components, EDM (Electrical Discharge Machining), ECM(Electrochemical Machining), Laser Beam Machining (LBM), Ultrasonic Machining (USM), Water Jet Machining (WJM), Tooling, accuracy, and material selection, Applications in sensors housing, precision end-effectors.	04
4.	**CNC and CAD/CAM for Robotic Part Production:** Basics of CNC machines: structure, types, coordinate systems, G & M codes, CNC programming for robotic brackets, links, CAD modeling and CAM integration, Tool path generation and post-processing, Case study: CNC-machined aluminum robotic gripper.	05
5.	**Additive and Hybrid Manufacturing for Robotics:** Introduction to Additive Manufacturing (AM): FDM, SLA, SLS, DMLS, Materials used in AM for robotic applications (plastic, metal, composites), Rapid prototyping and functional part production, Hybrid manufacturing (Additive + Subtractive), Applications in humanoid robotics, wearable exoskeletons, soft robotics	05
6.	**Intelligent Manufacturing and Industry 5.0 in Robotics** Manufacturing Automation: Types and levels, Role of PLC, SCADA, sensors, vision systems, Industry 5.0 concepts: IoT, Digital Twin, Cyber-Physical Systems, Smart Factory and robotic cell integration, Case studies: Manufacturing Industry dealing with robots.	04
	TOTAL	**28**

List of Experiments:

Students have to perform Any 7 experiments from 1 to 8 in workshop/laboratory related to following topics. Experiment 9 is compulsory.

1. Preparation of a mould for single piece pattern/ split pattern
2. Melting and casting of aluminum metal
3. Study and practices in TIG/MIG welding process
4. Job involving various operations on lathe (step, taper turning)
5. Job involving various operations on lathe (drilling, chamfering, knurling)
6. Prepare prototype using 3D Printing/additive manufacturing.
7. Use CAM software to generate tool paths and simulate machining of a robot part.
8. Case studies on Intelligent Manufacturing.
9. Industrial visit to manufacturing plants and its report.

Text Books:

1. M. P. Groover, "Automation, Production Systems and CIM", Pearson.
2. G. W. Rowe, "Principles of Industrial Metal Working Process", Edward Arnold.
3. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering & Technology", Pearson.
4. R. S. Parmar, "Welding Process and Technology", 2nd Edition, Khanna Publishers.

Reference Books:
1. Amitabha Ghosh and Ashok Kumar Mallik, "Manufacturing Science", Affiliated East-West Press. 2. T. K. Kundra, P. N. Rao and N. K. Tiwari, "Numerical Control and CAD/CAM", Tata McGraw-Hill. 3. V. Jayakumar, "Introduction to Smart Manufacturing", McGraw Hill. 4. Serope Kalpakjian, "Manufacturing Processes for Engineering Materials", Pearson.
E-Resources:
1. https://onlinecourses.nptel.ac.in/noc25_me156/preview 2. https://onlinecourses.nptel.ac.in/noc25_me151/preview 3. https://library.iitbbs.ac.in/e-resources 4. https://www.sciencedirect.com/journal/journal-of-manufacturing-systems 5. https://scholar.google.com

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)								**Semester:** IV	
Course: Digital Electronics & Microcontrollers								**Code:** RAMD402	
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	02	--	04	40	60	--	--	25	125

Prerequisites:

Basic Electronics & Electrical Engineering

Course Objectives:

1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
2. To prepare students to perform the analysis and design of various digital electronic circuits.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand the Boolean algebra and its minimization techniques.
CO2	Design and analyse the sequential & combinational logic circuits.
CO3	Explain the difference between Microprocessors &Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.
CO4	Write 8051 Assembly level or C programs using 8051 instruction set.
CO5	Explain operation of Timers, ADC & DAC
CO6	To explain the architecture and operation of advance microcontrollers in robotics & automation

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Boolean Algebra**: Simplification of Boolean functions - special forms of Boolean functions minterm (SOP) maxterm (POS) - K Map representation of logic functions - simplification of logic functions using K Map – Don't care conditions, Quine McCluskey minimization method.	07
2.	**Sequential & Combinational Digital Circuits:** Sequential circuits – Latches and Flip-flops (D, T, S-R, J-K) shift registers **Combinational Digital Circuits** Half and Full Adders-Half and Full Subtractors - Code converters - Encoder-Decoder - Multiplexer- Demultiplexer - Binary/ BCD adders, subtractors - Carry look ahead adder- parity checker-parity generators- Magnitude comparator.	07
3.	**8051 Microcontroller:** Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.	07
4.	**8051 Instruction Set and Peripherals:** Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical	

	instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions. 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode- 2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS- 232 standard. Simple Serial Port programming in C to transmit a message and to receive data serially.	07
5.	**Interfacing and Programming:** Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.8051 C programming to generate a square waveform on a port pin using a Timers. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming.	07
6.	**Advance Microcontrollers:** ARM architecture overview. ARM Cortex-M4 (STM32) features. AVR (ATmega328): Architecture, features Comparison of 8051, AVR and ARM Difference between microprocessor and microcontrollers. Application of microcontrollers in robotics & automation.	07
	TOTAL	**42**

List of Experiments:

Students have to perform any 4 experiments from each group in laboratory related to following topics

Group A

1. Realization of Half Adder & Full Adder using Basic gates
2. Realization of Half Subtractor & Full Subtractor using Basic gates
3. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates
4. Design and verify Binary to Gray and Gray to Binary conversion using NAND gates only
5. Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates

Group B

1. Data Transfer: Block Move, Exchange, Sorting, Finding largest element in an array.
2. Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits
3. Arithmetic operations – bit addressable).
4. Programs to generate delay, Programs using serial port and on-Chip timer/counter.
5. Interfacing of LED to 8051.
6. Alphanumeric LCD panel and Hex keypad input interface to 8051.

7. DC motor control interface to 8051.
8. Write ALP to interface a Stepper Motor to 8051 to rotate the motor
9. Interfacing of ADC and DAC
10. Matrix Keypad interfacing with 8051.
11. **Case studies: Robotic arm control, Line follower robot, home automation, smart sensor node**

Text Books:

1. Adel S. Sedra, Kenneth C. Smith and Arun N. Chandorkar, "Microelectronic Circuits: Theory and Applications", Seventh Edition, Oxford University Press, 2017.
2. M. Morris Mano, "Digital Logic and Computer Design", PHI, 2000 Edition.
3. Muhammad Ali, "The 8051 Microcontroller and Embedded Systems – Using Assembly and C", PHI / Pearson, 2006.
4. Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition, Thomson/Cengage Learning.

Reference Books:

1. Donald A. Neamen, "Semiconductor Physics and Devices", 4th Edition, McGraw Hill, 2017.
2. Ramakant A. Gayakwad, "Opamp and Linear Integrated Circuits", 3rd Edition, PHI, 2007.
3. Manish K. Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.
4. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2005.

E-Resources:

E-book versions are available

1. https://youtu.be/7mtt4bdfQk4
2. https://onlinecourses.swayam2.ac.in/ntr25_ed125/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation)								**Semester:** IV	
Course: Quality Management System – II								**Code:** RAMC402	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	-	-	25

Prerequisites:

Interactive mind-set for practical and quality thinking.

Course Objectives:

Understanding the QMS clauses and its PDCA way of working in an organization.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand the organization and its functional alignment for QMS.
CO2	Understand the quality management system and processes.
CO3	Know the leadership drive and involvement in building quality culture.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	Scope, Normative References, Terms & Definition	04
2.	**Context of the Organization:** Understanding the organization and its context, Needs and expectations of interested parties, Determine the scope of the quality management system, Quality management system and its processes.	10
3.	**Leadership:** Accountability, Responsibilities and Commitment for QMS culture, Quality policy.	14
	TOTAL	**28**

Text Books:

1. Kanishka Bedi, "Quality Management", Oxford University Press.
2. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education.
3. Dale H. Besterfield, "Total Quality Management", Pearson Education.

Reference Books:

1. QMS ISO 9001:2015 Standards

E-Resources:

1. Dr. N.Venkateshwarlu, "Quality Engineering & Management", NPTEL Course, https://onlinecourses.swayam2.ac.in/nou25_me09/preview

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation))								**Semester:** IV	
Course: Problem Solving Techniques – II								**Code:** RAAE402	
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	25	-	-	25

Prerequisites:

Interactive mind-set for practical.

Course Objectives:

1. To acquire basic knowledge of Problem-solving planning.
2. To understand the effectiveness check and sustenance.

Course Outcomes: After completion of this course, students will be able to -

CO1	Know how to plan and execute the problem solving.
CO2	Understand the measure and monitoring of problem-solving plan and execution.
CO3	Understand the effectiveness measures of problem solving.
CO4	Understand the sustenance working plan and execution.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Planning & Execution:** What is planning? PDCA way of thinking and planning, Inputs requirement mapping.	08
2.	**Measure of Planning & Execution:** Key measures, How to measure and monitor? Reviews & Reporting with documentation.	08
3.	**Effectiveness measures & Sustenance:** Define effectiveness measures, How to measure and monitor? Importance of Sustenance, How to plan and execute sustenance activities.	12
	TOTAL	**28**

Text Books:

1. B. Mahadevan, "Operations Management: Theory and Practice", Pearson Education India.
2. L.M. Prasad, "Principles and Practices of Management", Sultan Chand & Sons.

Reference Books:

1. The PDCA Cycle for Industrial Improvement: Applied Case Studies (Synthesis Lectures on Engineering, Science, and Technology), Springer.

E-Resources:

1. Coursera, "Initiating and Planning Projects" - https://www.coursera.org/learn/project-planning

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics & Automation Engineering)							**Semester:** IV		
Course: Python for Robotics							**Code:** RAVS406		
Teaching Scheme (Hr/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	-	25	25

Prerequisites:

Basic knowledge of programming (any language), logic development, and electronics.

Course Objectives:

1. To introduce students to programming fundamentals using Python.
2. To develop logical thinking and coding skills applicable in robotics.
3. To provide hands-on experience in writing Python scripts for basic I/O and data handling.
4. To build a foundation for future robotic applications using Python.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand basic syntax, variables, and data types in Python.
CO2	Write Python programs using control structures and loops.
CO3	Use lists, strings, and functions to organize code efficiently.
CO4	Read input from the user and display output in formatted ways.
CO5	Understand and implement file handling and simple modules.
CO6	Develop basic sensor simulation and logic circuits using Python logic.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Python:** History of Python, installation, Python IDE, writing and running a Python program for basic robotic tasks, syntax, indentation in robot control code.	04
2.	**Variables and Data Types:** Integers, floats, strings, Booleans used in robot sensors and actuators, type conversion, input/output functions for user and sensor interaction.	04
3.	**Operators and Control Structures:** Arithmetic, comparison, logical operators applied in robotic decisions, if-else, nested conditions for task flow in autonomous robots.	04
4.	**Loops and Functions:** for, while, break/continue for repeated robotic actions, defining and calling functions for robot behaviors, parameters, return values for modular robot control.	04
5.	**Data Structures:** Lists, tuples, dictionaries, sets to manage sensor data and commands, indexing, slicing, basic operations on robotic data collections.	06

6.	**Introduction to Robotics with Python:** Simulating sensor logic, printing actuator patterns, mini I/O robotics projects using logic, basic serial input/output for hardware interfacing.	06
	TOTAL	**28**

List of Experiments:

1. Print "Hello, World!" and take user input
2. Use variables and perform arithmetic operations
3. Write a program using if-else to check threshold value
4. Use for and while loops to print number patterns
5. Create and manipulate a list of values
6. Define a function to calculate average of numbers
7. Use dictionary to store and access key-value pairs
8. File handling – read/write a simple text file
9. Use time delays with time. sleep() and print statements
10. Use basic logic with conditionals for directional decisions

Text Books:

1. Michael Driscoll, "Python 101", Mike Driscoll Publishing.
2. Charles Severance, "Python for Everybody", Open Access.

Reference Books:

1. Eric Matthes, "Python Crash Course", No Starch Press.
2. John Zelle, "Python Programming: An Introduction to Computer Science", Franklin.
3. Lentin Joseph, "Learning Robotics Using Python", Packt Publishing.

E-Resources:

1. W3Schools Python: https://www.w3schools.com/python/
2. Real Python (Beginner to Advanced): https://realpython.com/
3. Python for Everybody (Dr. Chuck): https://www.py4e.com/
4. Programiz Python: https://www.programiz.com/python-programming
5. The Construct – Python for Robotics: https://www.theconstructsim.com/robotigniteacademy_learnpython/

DEPARTMENT OF ROBOTICS & AUTOMATION ENGINEERING

Program: B. Tech. (Robotics and Automation)								**Semester:** IV	
Course: Internship – III								**Code:** RAIN403	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	-	-	02	-	-	25	-	-	25

Preamble:

Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.

Course Objectives:

1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry.
2. Learn to implement the technical knowledge in real industrial situations.

Course Outcomes: After completion of this course, students will be able to -

CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.

Internship Requirements

1. **Internship Duration:** It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW).
2. **Internship Opportunities:** Students can explore various opportunities for internships at:
    a. Industries
    b. Research labs or organizations
    c. Collegiate clubs
    d. In-house research projects
    e. Online internships
3. **Support and Assistance:** Students can seek assistance for securing internships from:
    a. The Training and Placement cell, along with departmental coordinators
    b. Department or institute faculty members
    c. Personal contacts
    d. Directly connecting with industries or organizations
4. **Request Letter:** Once an industry, research organization, or collegiate club is identified,

students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.