RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2023 – 2024

DEPARTMENT OF MECHANICAL ENGINEERING

I - IV SEMESTER M. TECH

ROBOTICS AND ARTIFICIAL INTELLIGENCE (RAI)

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 17 UG programs and 15 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^+' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 67% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 107 & world ranking 600 for the year 2022.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology is recognized by Atal Ranking of Institutions on Innovation Achievements (ARIIA), MoE, Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, Ramaiah Institute of Technology has achieved 78^{th} rank among 1314 top Engineering Institutions & 23^{rd} Rank for School of Architecture in India for the year 2023.

About the Department

The Department of Mechanical Engineering started in 1962 with an intake of 40 students. The department has grown strong over the last 52 years and today has an intake of 180 students and 43 teaching staff. All the faculty members are well qualified and possess post graduate degrees with 29 doctorates. The department offers a four-year degree course and also offers two Master's Degrees in Manufacturing Science & Engineering and Robotics and AI, with an intake of 18 each. The Department also offers a research program which includes MSc Engineering by research and PhD degree from Visvesvaraya Technological University and at present 11 researchers are pursuing PhD. The department received software grants from Autodesk, a leading Computer Aided Design multinational company and has been using them in the curriculum. The faculty members have taken up a number of research projects funded by external agencies like DRDO, DST, AICTE and Visvesvaraya Technological University and received funding to the tune of 1 Crore. In view of the golden jubilee celebrations, the department has conducted a national level project exhibition and an International Conference on "Challenges and Opportunities in Mechanical Engineering, Industrial Engineering and Management Studies" – ICCOMIM. Faculty members from the department have published books on different domains of Mechanical Engineering and are recommended by Visvesvaraya Technological University Board of Studies as reference text books.

The students from the department participate both at the national and international competition throughout the year, in the year 2013 – AeRobusta – 4-member student team from the department participated in SAE Aero Design competition and stood 18th position out of 64 teams from all over the world. The team AeRobusta stood FIRST AMONG THE ASIAN COUNTRIES.

Another team from the department also participated in the "Unmanned Air Vehicle System "conducted by the U.S. Navy at Maryland, USA. The team secured 5th Place in the technical session out of 36 participating teams from all over the world.

A team of two students also participated in the CAD Design Competition conducted by Autodesk, a CAD multinational company, in association with IIT Madras and secured FIRST PLACE among the teams from all over India with a cash prize of Rs1,20,000 and also received a free Trip to Autodesk University, held at Las Vegas, USA.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To be a centre of International repute in Mechanical Engineering and to create qualified human resources needed to meet the demanding challenges in different areas and emerging fields of Mechanical Engineering and allied sciences.

MISSION OF THE DEPARTMENT

To impart quality technical education to meet the growing needs of the profession through conducive and creative learning environment, to produce qualified and skilled human resources, create R&D environment, to be a centre of excellence and to offer post graduate programs in the emerging fields of Mechanical Engineering.

Process of deriving the vision and mission of the department

Process of deriving the vision and mission of the department is shown in block diagram below (fig1)

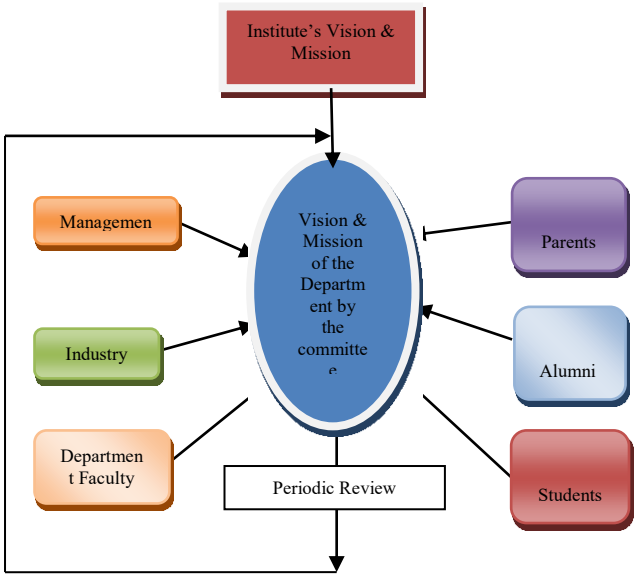

Fig1. Block Diagram – Deriving the Vision & Mission of the department

Programme Educational Objectives (PEOs)

The Mechanical Engineering Program, M.Tech-CIM is a four semester course and will provide the advanced building blocks for conceptualizing, understanding and optimizing manufacturing systems integrated with computer based applications. These building blocks will include advanced materials, traditional and non-traditional manufacturing methods, Advanced trends in manufacturing management, Robotics, Computer aided design, Flexible Manufacturing Systems, Computer control in manufacturing systems, Condition based Maintenance, Automation in manufacturing, Advanced material Technology, Rapid Prototyping, etc. the course includes an individual project work by the student to help him understand his learning and apply the principles to practical situations and would enable the student to be technically and professionally equipped and improve for taking up challenges in the industrial sector, government organization, research organizations and pursuing higher studies or for starting his or her own industry or entrepreneurship.

PEOs of the Program

PEO 1: Apply the technical skills gained to model and analyze real time projects in the field of Robotics and AI.

PEO 2: Able to take up profession in R&D areas, management and teaching activity in the field of mechanical engineering.

PEO 3: Engage in industry institute interaction and lifelong learning by adhering to ethical and environmental conditions.

Process of Deriving the Programme Educational Objectives (PEOs):

Fig 2 shows the process employed for deriving the PEO's

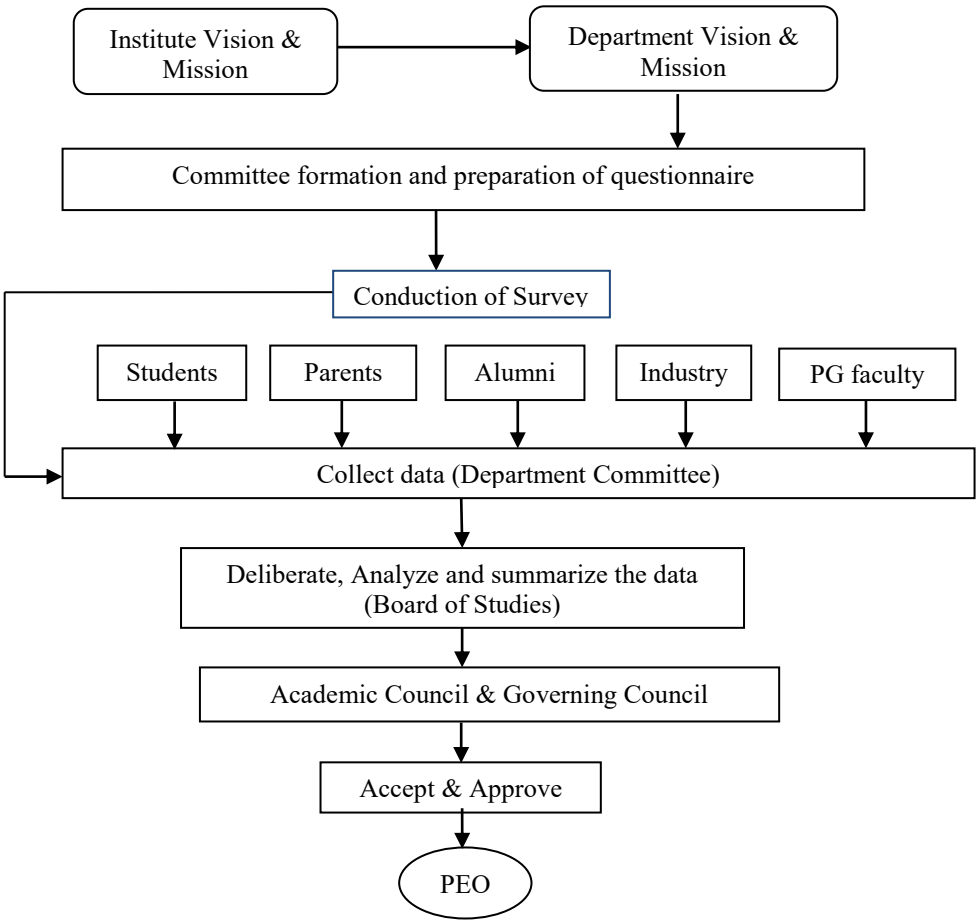

Fig 2 : Process employed for deriving the PEO's of the department

Programme Outcomes (POs):

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Be able to demonstrate a degree of mastering over the area as per the specialization of the Programme. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: An ability to identify problems, explore opportunities, propose feasible solutions and adopt latest computer-integrated manufacturing tools, to transform into an accomplished Robotics and AI engineer.

PO5: Ability to apply the learned principles to the analysis, development and implementation of the Robotics and AI; to prepare oneself to work professionally in academic institutions and industries.

Process of Deriving the Programme Outcomes (POs):

Fig 3 shows the process employed for deriving the PO's

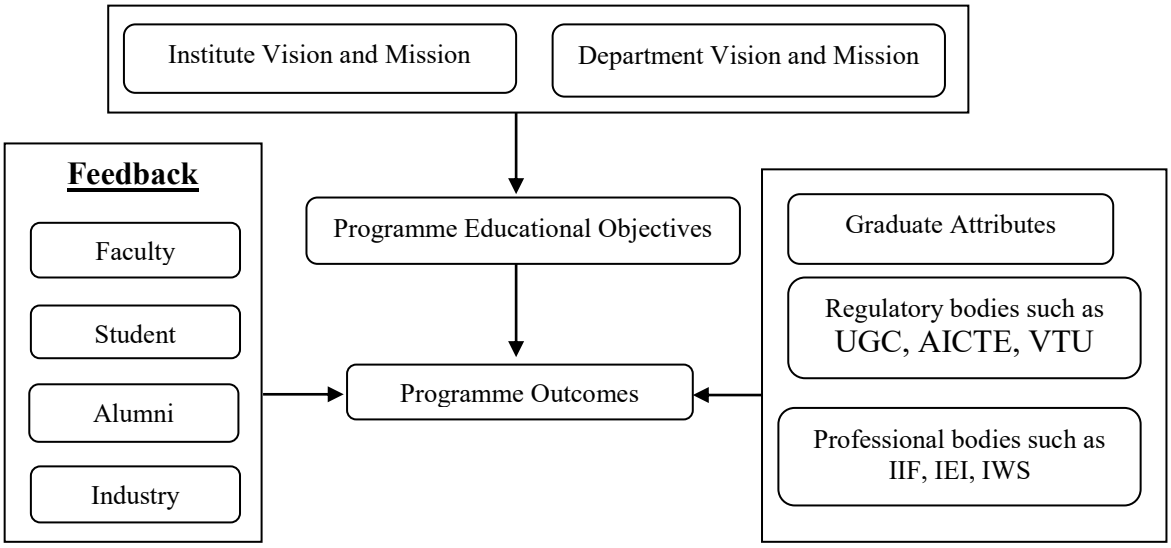

Fig 3: Process employed for deriving PO's

Mapping of PEO's and PO's

The correlation between the Programme outcomes and Program Educational objectives are mapped in the Table1 shown below.

Table 1: Correlation between the POs and the PEOs

Sl. No.	Programme Educational Objectives (PEOs)	Programme Outcomes (PO)				
		PO1	PO2	PO3	PO4	PO5
1	Apply the technical skills gained to model and analyze real time projects in the field of computer integrated manufacturing.	3	3	3	3	3
2	Able to take up profession in R&D areas, management and teaching activity in the field of mechanical engineering.	3	3	3	3	3
3	Engage in industry institute interaction and lifelong learning by adhering to ethical and environmental conditions.	3	3	3	3	3

Ramaiah Institute of Technology
Department of Mechanical Engineering

PG Curriculum Course
M.Tech in Robotics and AI
Credits 80

Semester	Professional Core Course	Professional Course Lab	Professional Elective Course	Mandatory Credit Course	Project Work / Seminar	Internship	Total Semester Credit
First	6	2	11	3	-	-	22
Second	8	2	12	-	-	-	22
Third	4	-	4	-	4	4	16
Fourth	-	-	-	-	20	-	20
Total	18	4	27	3	24	4	80

Ramaiah Institute of Technology
Department of Mechanical Engineering
PG Curriculum 2023 - 2024
1st Semester

M.Tech in Robotics and AI Scheme of Teaching and Examination 2023 - 2024									
I SEMESTER									
Sl No	**Subject Code**	**Subjects**	**Teaching Department**	**Category**	**Credits**				**Total Contact Hours / Week**
					L	**T**	**P**	**Total**	
1	RAI11	Machine Learning and Python	Mechanical Engineering	PCC	2	1	0	3	4
2	RAI12	Robotics and Programming		PCC	3	0	0	3	3
3	RAIE13X	Professional Core Course Elective – I		PEC	3	0	0	3	3
4	RAIE14X	Professional Core Course Elective – II		PEC	4	0	0	4	4
5	RAIE15X	Professional Core Course Elective – III		PEC	4	0	0	4	4
6	RM116	Research Methodology & IPR		MCC	3	0	0	3	3
7	RAIL17	Industrial Robotics Laboratory		PCCL	0	0	1	1	2
8	RAIL18	Python Programming Lab		PCCL	0	0	1	1	2
Total					**19**	**1**	**2**	**22**	**25**

Ramaiah Institute of Technology
Department of Mechanical Engineering
PG Curriculum 2022 - 2023
2nd Semester

M.Tech in Robotics and AI Scheme of Teaching and Examination 2023 - 2024									
II SEMESTER									
Sl No	**Subject Code**	**Subjects**	**Teaching Department**	**Category**	**Credits**				**Total Contact Hours / Week**
					L	**T**	**P**	**Total**	
1	RAI21	Artificial Intelligence and Neural networks	Mechanical Engineering	PCC	3	1	0	4	5
2	RAI22	Control Engineering		PCC	4	0	0	4	4
3	RAIE23X	Professional Core Course Elective – IV		PEC	4	0	0	4	4
4	RAIE24X	Professional Core Course Elective – V		PEC	4	0	0	4	4
5	RAIE25X	Professional Core Course Elective – VI		PEC	4	0	0	4	4
6	RAIL26	AI Laboratory		PCCL	0	0	1	1	2
7	RAIL27	Control System Laboratory		PCCL	0	0	1	1	2
Total					**19**	**1**	**2**	**22**	**25**

Ramaiah Institute of Technology
Department of Mechanical Engineering
PG Curriculum 2023 - 2024
3rd Semester

M.Tech in Robotics and AI **Scheme of Teaching and Examination 2023 - 2024**									
III SEMESTER									
Sl No	**Subject Code**	**Subjects**	**Teaching Department**	**Category**	**Credits**				**Total Contact Hours / Week**
					L	**T**	**P**	**Total**	
1	RAI31	Robot Gripper Analysis	Mechanical Engineering	PCC	3	1	0	4	4
2	RAIE32x	Professional Elective Course – VII		PEC	4	0	0	4	4
3	RAII33	Internship/Industrial Training		INT	0	0	4	4	4
4	RAIP34	Project Work – I		PW	0	0	4	4	4
Total					**7**	**1**	**8**	**16**	**16**

Ramaiah Institute of Technology
Department of Mechanical Engineering
PG Curriculum 2023 - 2024
4th Semester

M.Tech in Robotics and AI **Scheme of Teaching and Examination 2023 - 2024**									
III SEMESTER									
Sl No	**Subject Code**	**Subjects**	**Teaching Department**	**Category**	**Credits**				**Total Contact Hours / Week**
					L	**T**	**P**	**Total**	
1	RAIP41	Project Work – II	Mechanical Engineering	PW	0	0	20	20	20
				Total	**0**	**0**	**20**	**20**	**20**

LIST OF ELECTIVES - (Robotics and AI)

Sl. No.	Course Code	Course	Credits			
			L	T	P	Total
THREE CREDIT COURSE						
1	RAIE131	Soft Computing	3	0	0	3
2	RAIE132	Robot System Design	3	0	0	3
FOUR CREDIT COURSE						
1	RAIEXX1	Sensors and Actuators for Robotics	4	0	0	4
2	RAIEXX2	Computer Aided Design	4	0	0	4
3	RAIEXX3	Internet of Things for Robots	4	0	0	4
4	RAIEXX4	Robot Operating Systems	4	0	0	4
5	RAIEXX5	Additive Manufacturing	4	0	0	4
6	RAIEXX6	Robotic Process Automation	4	0	0	4
7	RAIEXX7	Mechatronics and MEMS	4	0	0	4
8	RAIEXX8	Computer Aided Process Planning	4	0	0	4
9	RAIEXX9	Fundamentals of Data Analytics using R	4	0	0	4
10	RAIEXX10	Hydraulics and Pneumatics	4	0	0	4
11	RAIEXX11	Autonomous Mobile Robots	4	0	0	4
12	RAIEXX12	Industrial and Collaborative Robots	4	0	0	4
13	RAIEXX13	Robot Kinematics and Dynamics	4	0	0	4
14	RAIEXX14	Introduction to Deep Learning	4	0	0	4
15	RAIEXX15	Natural Language Processing	4	0	0	4
16	RAIEXX16	Computer Vision using AI	4	0	0	4
17	RAIEXX17	Finite Element Method for structural analysis	4	0	0	0

Students have to earn a total of 80 credits by choosing subjects from the above list of electives.

MACHINE LEARNING AND PYTHON	
Course Code: RAI11	**Credits: 2:1:0**
Prerequisite: Probability, Statistics	**Contact Hours: 28+14**
Course Coordinator: Dr. Jaya Christiyan K G	

Course Contents

Unit I

INTRODUCTION TO PYTHON

Introduction, Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; Variables, Expressions and Statements: Values and data types, Variables, Variable names and keywords, Conditional Statements, Evaluating expressions, Operators and operands, Type converter functions, Order of operations, Operations on strings, Input, Composition, The modulus operator. Iteration: Assignment, Updating variables, the for loop, the while statement, Functions: Functions with arguments and return values, Lambda Functions

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: https://www.learnbyexample.org/python/ https://www.learnpython.org/ https://pythontutor.com/visualize.html#mode=edit

Unit II

STRINGS, LISTS, TUPLES, DICTIONARIES

Strings: string slices, immutability, string functions and methods, string module. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters. Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; Files: About files, writing our first file, reading a file line-at-a-time, turning a file into a list of lines, Reading the whole file at once, working with binary files,

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Python programming
- Links: Introduction to strings https://www.learnbyexample.org/python/ https://www.learnpython.org/ https://pythontutor.com/visualize.html#mode=edit
  list https://youtu.be/neTsPE9XFsQ

Unit III

INTRODUCTION TO MACHINE LEARNING, CONCEPT LEARNING

What is Machine Learning, Benefits, opportunities and risk for the mechanical engineering, Well-posed learning problems, Designing a learning system, Perspectives and Issues, a concept learning task, Concept learning as search, Find-S: Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Python programming
- Links: Introduction to Machine Learning https://youtu.be/ukzFI9rgwfU
  Concept Learning https://youtu.be/z5AKsT3apWI

Unit IV

DECISION TREES AND REGRESSION

Decision tree learning: Representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Introduction to Linear and Non-Linear regression

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Python programming
- Links: Decision Trees https://youtu.be/FuJVLsZYkuE
  Regression https://youtu.be/VWCRDH1_rv0

Unit V

BAYESIAN LEARNING, INSTANCE BASED LEARNING

Bayes Theorem and Concept learning, Maximum Likelihood and Least Squared Error, Maximum Likelihood hypotheses for predicting probabilities Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Instance based learning: k-nearest neighbor learning.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Lab component/ Practical topics: Python programming
- Links: Bayesian Learning https://youtu.be/E3l26bTdtxI
  Instance Based Learning https://youtu.be/EenF9JIc_H4

Text Books:

1 Think Python: How to Think Like a Computer Scientist Allen B. Downey Shroff O'Reilly Publishers 2nd edition 2016
2 An Introduction to Python – Revised and updated for Python 3.2 Guido van Rossum and Fred L. Drake Jr Network Theory Ltd., 2011
3 Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013

Reference Books:

1 Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd 2016
2 Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning 2012
3 Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Course Outcomes (COs):

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

1. Read and write by hand simple Python programs [PO1,PO2,PO3,PO4 & PO5]
2. Outline the preliminaries of machine learning and apply concept learning to real time scenarios.
3. Illustrate the working of Decision trees. [PO1,PO2,PO3,PO4 & PO5]
4. Describe Bayesian learning algorithm and its variants, Instance based learning. [PO1,PO2,PO3,PO4 & PO5]
5. Investigate concept learning, Bayes classifier, k nearest neighbour, Regression. [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz/project	10	CO-1,CO-2, CO-3
Assignment	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ROBOTICS AND PROGRAMMING	
Course Code: RAI12	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42**
Course Coordinator: Dr. Sunith Babu L	

Course Contents

Unit I

Concepts of Robotics Introduction, Robot Definition, Laws of Robotics, Chronological Development of Robot Technology, Laws of Robots, Classifications of Robots, Advantages and Applications of Robots, Robot Components, Degrees of Freedom, Joints and Notation Scheme, Coordinates, Reference Frames, Robot Motions, Robot System Integration

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=0ZnG16reUfc

Unit II

Configuration and Work Volume – Human Body, Human Work Volume, Industrial Robot Configuration, Structural Configuration and Robot Work Volume of industrial robot, Precision of Movement, Degrees of Freedom,

End Effectors – Introduction, Prehension, Automatic Prehension, Impactive Mechanical Grippers, Ingressive Grippers, Astrictive Prehension, Magnetic, Vacuum, Adhesive, Flexi / Soft Grippers, Selection of Grippers

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=edMYmTu5I7Y

Unit III

Coordinate Transformation – Introduction to D-H parameters, Introduction, 2D & 3D Coordinate Transformation, Inverse Transformation, Kinematic Chain, Composite Transformation Matrix, Composite Transformation Matrix, Algorithm, Wrist

Kinematics - Introduction, Joint Coordinate Space, Kinematics and Inverse Kinematics, Two Joint – Two DoF Robot, Homogeneous Transformation

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=BiYu9_BXSBU

Unit IV

Robot Programming – Teach Pendant, Graphical Programming, Robot Simulation, Software, Offline Programming, Macro Programming, Manual Control, Sensor – Based Programming, Hand Guided Collaborative Teaching, Robot Operating System,

FANUC Robot Codes and Syntax - Introduction to FANUC Robot Programming, Types of Controllers and Cabinet – A, B, Mate, Open Air, Registers. Syntax - Numeric Registers, Position Registers, Flags, Frames, Main Routines, CALL, IF, JMP, LBL, L, J, UTOOL, UFRAME, WAIT,

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=sCTgZv33tuA

Unit V

Industrial Applications of Robots and Cobots – Robot Selection Consideration, Robots in Industry, Pick and Place, Spray Coating, Assembly, Inspection, Welding Robots, Machine Loading and Unloading, Material Transfer, Palletization, Application of Robots in industries, Special Applications – iRobot (Roomba), KiloBot Spot Mini (Boston Dynamics), Sophia, Robobees, Swarm Robots

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=sCTgZv33tuA

Text Book:

1. Introduction to Robotics Analysis, Control, Applications Saeed B. Niku, John Wiley & Sons INC, ISBN 978-0-470-60446-5
2. Introduction to Robotics, S K Saha, McGraw Hill Education, (India) Pvt Ltd, ISBN - 978-93-3290-280-0
3. Introduction to Industrial Robotics, Ramachandran Nagarajan, Pearson India, 978-93-325 4480-2

Course Learning Outcomes (COs):

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

1. Illustrate the robot key concepts and develop skill set in developing robot characteristics. [PO1, PO2, PO3,PO4 & PO5]
2. Develop appropriate robot work volume and energy efficient grippers for specific applications [PO1, PO2, PO3, PO4 & PO5]
3. Prepare forward and inverse kinematics and provide solutions as per the applications. [PO1, PO2, PO3, PO4 & PO5]
4. Identify the methods to control a robot using different programming languages [PO1, PO2, PO3, PO4 & PO5]
5. Provide an understanding of the robot applications in different fields of Engineering [PO1, PO2, PO3, PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests will be taken for 30 marks		
Other Components	**Marks**	**Course outcomes addressed**
Assignment Quiz Presentation	20 (10+10)	CO1, CO2,CO3, CO4, CO5
Model/mini project		
Any other		
Semester End Examination (SEE)		
Semester End Examination: (Scaled to 50)	100	CO1, CO2, CO3, CO4, CO5

INDUSTRIAL ROBOTICS LABORATORY	
Course Code: RAIL 17	**Credits: 0:0:1**
Prerequisite: Industrial Robotics	**Contact Hours: 14**
Course Coordinator: Dr. Sunith Babu L	

PART – A

(ROBOGUIDE - SOFTWARE)

Robot Selection and Work cell creation
System Integration for Material Handling for Pick and Place
Programming of robot using Teach Pendant
Gripper Movement using Linear and Circular Path

PART – B

(FANUC – M10ID/12 MATERIAL HANDLING ROBOT)

Control of Robot using Teach Pendant
Application of Vacuum Gripper
Application of Magnetic Gripper
Application of Two Jaw and Three Jaw Gripper for ID and OD application

Reference:

1. Help Manual of RoboGuide V9.0

Scheme of Examination – Exam Marks: 50
Duration 3 Hours
Students per Batch in Examination – FIVE ONLY

Component	Marks
Part A	20
Part B	20
Viva Voce	10
Total	50

Course Outcomes (COs):

Students will be able to:

1. Create a Robotic Work cell using Robot Software (PO1,PO2,PO3,PO4,PO5)
2. Generate Robot Programs for a material handling application using Teach Pendant Robot (PO1,PO2,PO3,PO4,PO5)
3. Develop a Path Planning Sequence of End of Arm Tooling for a given application.
4. (PO1,PO2,PO3,PO4,PO5)

PYTHON PROGRAMMING LAB	
Course Code: RAIL18	**Credits: 0:0:1**
Prerequisite: Probability, Statistics	**Contact Hours: 14**
Course Coordinator: Dr. Jaya Christiyan K G	

1. Write a python program to convert the given strings to lowercase letters to uppercase letters and vice versa.
   Input: ramaiah Output:RAMAIAH
   Input: MECHANICAL Output: mechanical

2. Write a Python program to get a string made of the first 2 and the last 2 chars of a given string. If the string length is less than 2, return instead of the empty string.

3. With a given list **L of integers**, write a program to print this list L after removing all duplicate values with original order preserved.

4. You are provided with a number **D** containing only digits 0's and 1's. Your aim is to convert this number to have all the digits same.
   For that, you will change exactly one digit i.e. from **0 to 1** or from **1 to 0**. If it is possible to make all digits equal (either all 0's or all 1's) by flipping exactly 1 digit then output "YES", else print "NO" (quotes for clarity).
   Input Format:
   The first line of the input contains the number **D** made of only digits 1's and 0's.
   Output:
   Print 'YES' or 'NO' depending on whether its possible to make it all 0s or 1s or not.
   Example-1:
   Input: 101
   Output: YES
   Example-2:
   Input: 11
   Output: NO

5. Given a list of **n-1** numbers ranging from **1 to n**, your task is to find the missing number. There are no duplicates.
   Input Format:
   The first line contains **n-1** numbers with each number separated by a space.
   Output Format:
   Print the missing number
   Example:
   Input:
   1 2 4 6 3 7 8
   Output:
   5

6. Given a list **A** of elements of length **N**, ranging from **1 to N**. All elements may not be present in the array. If the element is not present then there will be -1 present in the array. Rearrange the array such that **A[i] = i** and if i is not present display -1 at that place.
   Input Format:
   The first line contains n numbers with each number separated by a space.
   Output Format:
   Print the elements of the list after the modification.
   Example:
   Input:
   -1 -1 6 1 9 3 2 -1 4 -1
   Output:
   -1 1 2 3 4 -1 6 -1 -1 9

7. Given a square matrix with **n** rows and **n** columns, you have to write a program to rotate this matrix such that each element is shifted by one place in a clockwise manner.
   For example, given the following matrix
   1 2 3
   4 5 6
   7 8 9
   The output should be
   4 1 2
   7 5 3
   8 9 6

8. Given a positive integer number **n**, you have to write a program that generates a dictionary **d** which contains **(i, i*i*i)** such that **i** is the key and **i*i*i** is its value, where **i** is from **1 to n (both included)**.
   Then you have to just print this dictionary **d**.
   Example:
   Input: 4
   will give output as
   {1: 1, 2: 8, 3: 27, 4: 64}

9. Write a program that calculates and prints the value according to the given formula:
   Q = Square root of [(2 * C * D)/H]
   Following are the fixed values of **C** and **H**:
   C is 50. **H** is 30.
   D is the variable whose values should be input to your program in a comma-separated sequence.
   Input Format:
   A sequence of values for D with each value separated by a comma.
   Output Format:
   Print the sequence of Q values with each value separated by a comma.
   Example:
   Input:
   100,150,180
   Output:
   18,22,24

10. Write a program that accepts a comma-separated sequence of words as input and prints the words in a comma-separated sequence after sorting them alphabetically.
    Input Format:
    The first line of input contains words separated by the comma.
    Output Format:
    Print the sorted words separated by the comma.
    Example:
    Input:
    without,hello,bag,world
    Output:
    bag,hello,without,world

11. Write a program, which will find all such numbers between **m** and **n** (both included) such that each digit of the number is an even number.
    Input Format:
    The first line contains value **m** and **n** separated by a comma.
    Output Format:
    The numbers obtained should be printed in a comma-separated sequence on a single line.
    Constraints:
    1000<=m<=9000
    1000<=n<=9000

12. Write a program that prompts for a file name, then opens that file and reads through the file, and print the contents of the file in upper case. Use the file words.txt to produce the output below.You can download the sample data at http://www.py4e.com/code3/words.txt

13. Open the file romeo.txt and read it line by line. For each line, split the line into a list of words using the split() method. The program should build a list of words. For each word on each line check to see if the word is already in the list and if not append it to the list. When the program completes, sort and print the resulting words in alphabetical order. You can download the sample data at http://www.py4e.com/code3/romeo.txt.

14. Open the file mbox-short.txt and read it line by line. When you find a line that starts with 'From ' like the following line: From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008You will parse the From line using split() and print out the second word in the line (i.e. the entire address of the person who sent the message). Then print out a count at the end.
    Hint: make sure not to include the lines that start with 'From:'. Also look at the last line of the sample output to see how to print the count. You can download the sample data at http://www.py4e.com/code3/mbox-short.txt.

Course Outcomes (COs):

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

1. Demonstrate proficiency in handling loops and creation of functions (PO1,PO2,PO3,PO4,PO5)
2. Identify the methods to create and manipulate lists, tuples and dictionaries. (PO1, PO2,PO3,PO4,PO5)
3. Develop programs using modules OOPS and files. (PO1,PO2,PO3,PO4,PO5)

Scheme of Examination – Exam Marks: 50, Duration 3 Hours,

ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS	
Course Code: RAI21	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Dr. Lokesha	

Preamble

AI is a branch of computing science that deals with the specification, design and implementation of information systems that have some knowledge related to the enterprise in which the information systems are situated. Furthermore, such systems are designed per se to be responsive to the needs of their end-users. Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It is the branch of computer science that emphasizes on creating intelligent machines that work and react like humans.

Unit I

Introduction to AI and production systems: Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Heuristic Search Techniques.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://www.youtube.com/watch?v=SSE4M0gcmvE

Unit II

Knowledge Representation Issues: Representations and Mappings, Approaches to knowledge representation. Issues in knowledge representation.

Use of Predicate Logic: Representing simple facts, Instance and ISA relationships, Computable Functions and Predicates, Resolution, Natural deduction.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://www.youtube.com/watch?v=IhodKMPwShc

Unit III

Knowledge Representation Using Rules: Procedural Vs Declarative knowledge, Logic programming. Forward Vs Backward reasoning, matching.

Symbolic reasoning under uncertainty: No monotonic reasoning. Implementation Depth First Search and Breadth First Search.

Statistical And Probabilistic Reasoning: Probability and Bayes' theorem, Certainity factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic and simple exercises.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://www.youtube.com/watch?v=1lKsSiEsJ18
  https://study.com/academy/lesson/probabilistic-reasoning-artificial-intelligence.html
  https://www.youtube.com/watch?v=9iN3O_oL2ac

Unit IV

Neural Networks: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/ysVOhBGykxs

Unit V

Expert systems: Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links : https://youtu.be/rln_kZbYaWc
  https://youtu.be/__0nZuG4sTw
  https://youtu.be/R49U8pHnb4g.

Text Books:

1. Artificial Intelligence, Elaine Rich & Kevin Knight, 3rd Ed., M/H 2009.
2. Introduction to AI & ES, Dan W. Patterson, Prentice Hall of India, 1999.

Reference Books:

1. Principles of Artificial Intelligence, Springer Verlag, Berlin, 1981.
2. Artificial Intelligence in business, Science & Industry, Wendy B. Ranch 179
3. A guide to expert systems, Waterman, D.A., Addison – Wesley inc. 1986
4. Building expert systems, Hayes, Roth, Waterman, D.A. Addison – Wesley, 1983

Course Outcomes (COs):

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

1. Understand a AI-Problem formulation and production system concepts. [PO1, PO2, PO3, PO4 & PO5]
2. Solve the concept of knowledge representation issues and the forward, backward reasoning. [PO1, PO2, PO3, PO4 & PO5]
3. Ability to use of predicate logic to represent simple facts and Instances. [PO1, PO2, PO3, PO4 & PO5]
4. Identify a problem in statistical and probabilistic reasoning. [PO1, PO2, PO3, PO4 & PO5]
5. Demonstrate the various learning typical expert system. [PO1, PO2, PO3, PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE)- 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz/project	10	CO-1,CO-2, CO-3
Assignment	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

CONTROL ENGINEERING	
Course Code: RAI22	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Vishwanath Koti	

Course Content

Unit I

MODELLING OF SYSTEMS AND BLOCK DIAGRAM

Modelling of Systems and Block diagram: Introduction to Control Systems, Types of Control Systems, with examples. Concept of mathematical modelling of physical systems- Mechanical, Translational (Mechanical accelerometer, systems excluded), and Rotational systems, Analogous systems based on force voltage analogy and force current analogy. Introduction to Block diagram algebra. Numerical problems on all topics.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentations
- Links: https://nptel.ac.in/courses/107106081
  https://www.javatpoint.com/control-system-block-diagram
  https://www.javatpoint.com/control-system-transfer-function

Unit II

SIGNAL FLOW GRAPH AND TIME RESPONSE ANALYSIS

Signal Flow graph: Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula.

Time response analysis: Introduction. Standard test signals, response of first order & second order systems for unit step input. Steady state errors & Error constants. Numerical problems on all topics.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.javatpoint.com/control-system-signal-flow-graphs
- https://www.javatpoint.com/control-system-time-response-analysis

Unit III

Concepts of stability and Frequency domain Analysis

Concepts of stability: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion.

Frequency domain Analysis: Introduction to frequency domain analysis, Correlation between time & frequency response

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://nptel.ac.in/courses/107106081
  https://www.javatpoint.com/stability-conditions
  https://www.javatpoint.com/control-system-routh-hurwitz-stability-criterion
  https://www.javatpoint.com/basic-concepts-of-frequency-response

Unit IV

ROOT LOCUS TECHNIQUE AND BODE PLOTS

Root Locus Technique: Introduction. Root locus concepts. Construction of root loci. Stability analysis using Root locus Technique Numerical problems on all topics.

Bode Plots: Introduction to frequency domain analysis Bode plots

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://nptel.ac.in/courses/107106081
  https://www.javatpoint.com/basic-concepts-of-root-locus
  https://www.javatpoint.com/example-of-root-locus

Unit V

STATE VARIABLE ANALYSIS AND DESIGN

State variable analysis and design: Introduction, Concepts of state variables for linear discrete time systems, Diagonalization solutions of state equations, Concepts of controllability and observability, Pole placement by state feedback, Observer systems, problems.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://nptel.ac.in/courses/107106081
  https://www.javatpoint.com/control-system-state-space-model
  https://www.javatpoint.com/state-variable-analysis-examples-with-explanation

Text Books:

1. Modern Control Engineering: Katsuhiko Ogata, Pearson Education, 2008.
2. Control Systems Principles and Design: M. Gopal, TMH, 2010
3. Control Engineering: U.A.Bakshi & V.U. Bakshi, Technical publications, Pune,2009
4. Control Systems Engineering: Nise, Wiley, Fourth edition

Reference Books:

1. Feedback Control Systems: Schaum's series 2010.
2. Control systems: I.J. Nagarath & M. Gopal, New age International publishers 2012.
3. Automatic Control Systems – B.C. Kuo, F. Golnaraghi, John Wiley & Sons, 2008.
4. Modern control Engineering: Dorf Bishop, Pearson, Eleventh edition

Course Outcomes (COs):

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

1. Demonstrate the concepts of Control systems and its Specifications for mathematical modelling, feedback control and stability analysis in Time and Frequency domains [PO1, PO2, PO3, PO4, PO5]
2. Express and solve system equations in state-variable form (state variable models), Identify open and closed loop control system to Solve Signal Flow graph and reduction of Block diagram [PO1, PO2, PO3, PO4, PO5]
3. Apply root-locus and Routh–Hurwitz stability criterion technique to analyze and design control systems [PO1, PO2, PO3, PO4, PO5]

4. Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs Formulate mathematical modelling of physical systems (Mechanical and Electrical System) [PO1, PO2, PO3, PO4, PO5]
5. Solve system equations in state-variable form (state variable models) [PO1, PO2, PO3, PO4, PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

AI LABORATORY	
Course Code: RAIL26	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Dr. Lokesha	

Course Objectives

1. To introduce the application of AI autonomous systems.
2. To develop simple AI system to drive autonomously for an application.
3. To demonstrate the AI application in mechanical engineering applications.

List of exercises

1. 3D Object Scanning
2. Augmented Reality (AR) for Mechanical Maintenance
3. Autonomous Drone
4. Fluid Dynamics Simulation
5. Human-Robot Interaction
6. Structural Health Monitoring
7. Autonomous Agricultural Robot
8. Robotic Vision System
9. Traffic Light Detection System
10. Driver Monitoring System

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://www.kettering.edu/research/research-facilities/autonomous-driving-and-artificial-intelligence-laboratory
  https://availab.org/
  https://www.matter.toronto.edu/basic-content-page/ai-for-discovery-and-self-driving-labs

Text Books:

1. Artificial Intelligence, Elaine Rich & Kevin Knight, 3rd Ed., M/H 2009.
2. Laboratory Manual

Reference Books:

1. Principles of Artificial Intelligence, Springer Verlag, Berlin, 1981.
2. NVIDIA component manual

Course Outcomes (COs):

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

1. Understand a AI-Problem formulation with circuit development. [PO1, PO2, PO3, PO4 & PO5]
2. Develop and solve the application oriented AI problems. [PO1, PO2, PO3, PO4 & PO5]
3. Demonstrate the various learning of AI in mechanical engineering applications. [PO1, PO2, PO3, PO4 & PO5]

CONTROL ENGINEERING LAB	
Course Code: RAIL 27	**Credits: 0:0:1**
Prerequisite: Nil	**Contact Hours: 28**
Course Coordinator: Dr. Vishwanath Koti	

LIST OF EXPERIMENTS

Part A

1) Obtain Time response of second order system (RLC circuit) and find time domain specifications of the same. And simulate the same using MATLAB.
2) Obtain frequency response of second order system (RLC circuit) and find time domain specifications of the same. And simulate the same using MATLAB.
3) Design and implementation of RC lead compensator. And verify the results using MATLAB.
4) Design and implementation of RC lag compensator. And verify the results using MATLAB.
5) Implementation of RC Lag-Lead compensator.

Part B

1) Simulate DC position control System for PI Controller
2) Simulate DC position control System for PD Controller and PID Controller.
3) To draw root loci for different transfer functions using MATLAB and verification by theoretical method, Obtain phase margin, gain margin for different transfer function by drawing Bode plot using MATLAB and verification by theoretical method
4) Introduction to SIMIAM package for Mobile robotics. Implementation of PID Control for Go To Goal application.
5) Implementation of PID Control for obstacle avoidance application.

Text Books:

1. J. Nagrath and M. Gopal,' Control Systems Engineering', 4th edition

Reference Books:

1. K. Ogata,' Modern Control engineering ', 4th edition.
2. Benjamin Kuo, 'Automatic Control Systems', PHI, 7th Edition.

Course Outcomes (COs):

1. At the end of the course the students will be able to:
   Analyse time domain response for different damping ratio. [PO1, PO2, PO3, PO4 & PO5]
2. Analyse the stability of the system by various methods. [PO1,PO2,PO3,PO4 & PO5]
3. Analyse the behaviour of mobile robots for different PID co-efficient and design the appropriate compensator. [PO1,PO2,PO3,PO4 & PO5]

ROBOT GRIPPER ANALYSIS	
Course Code: RAI31	**Credits: 3:1:0**
Prerequisite: Nil	**Contact Hours: 42L+14T**
Course Coordinator: Deepak S	

Course Content

Unit I

Introduction to prehension technology: Grippers for mechanization and automation, definitions, conceptual basics, Historical overview of technical hands

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=X0XGure7mak

Unit II

Impactive mechanical grippers: Gripper drivers, Electromechanical drives, pneumatic drives, electro strictive and piezo electric actuation, parallel impactive grippers, Internal grippers, rotatable jaw grippers, self-securing grippers, three finger gripper, four-point gripper and four point prehension.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=3OjhoVuAQkQ

Unit III

Miniature grippers and micro grippers: Impactive microgrippers, electro mechanically driven impactive micro grippers, vacuum microgrippers, contigutive micro grippers

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=ZKOI_lVDPpw

Unit IV

Tool exchange and reconfigurability: Multiple gripper transfer rails, turrets, specialized grippers, gripper exchange systems, manual and automatic exchange systems, Integrated processing

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=V0Y4mJLtLFU

Unit V

Instrumentation and control & Compliance: Gripper sensor technology, Finger position measurement, Sensory integration, discrete and continues sensing, Remote centre compliance, Near collet compliance, part feeding, Mechanical compliance, shape adaptive grippers, collision protection and safety.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=IalkWUN6wvE

Text Books:

1. **Robot grippers**, Gareth J. Monkman, Stefan Hesse, Ralf Steinmann, Henrik Schunk John Wiley & Sons, 27-Feb-2007 - Technology & Engineering.
2. **Sensors, Actuators, and Their Interfaces: A multi-disciplinary introduction (Control, Robotics and Sensors)** 2nd Edition, Nathan Ida, IET ISBN-13: 978-1785618352,2011
3. Deb, S. R., and Sankha Deb. 2010. "Robot Drives, Actuators and Control." Chap.3 in Robotics Technology and Flexible Automation. 2nd ed. New York: McGraw-Hill Education

References Books:

1. H.R. Everett, **"Sensors for mobile robots: Theory and applications"**, A K PetersLtd,1995
2. James J.Allen, **"Micro Electro Mechanical System Design"**, CRC Press Publisher,2010

Course Outcomes (COs):

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

1. Explain the need of grippers for automation and mechanization. [PO1, PO2, PO3, PO4 & PO5]
2. Understand different Gripper drivers, Electromechanical drives, pneumatic drives, electrostrictive and piezoelectric actuation. [PO1, PO2, PO3, PO4 & PO5]
3. Understand and analyze micro grippers and its operation. [PO1, PO2, PO3, PO4 & PO5]
4. Explain Tool exchange and gripper exchange systems. [PO1, PO2, PO3, PO4 & PO5]
5. Understand Gripper sensor technology, Finger position measurement, Sensory integration, discrete and continuous sensing. [PO1, PO2, PO3, PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 & CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

INTERNSHIP/INDUSTRIAL TRAINING	
Course Code: RAII33	**Credits: 0:0:4**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Dr. Jaya Christiyan K G	

PREAMBLE:

Preamble: Any manufacturing engineering candidate would ultimately require ability for research or be able to solve problems in industries. Hence a candidate would be required to have a practical exposure to some typical industries. In this connection Industrial Training / Internship goes a long way in helping the candidates give an actual exposure to the industrial environment. Hence this course is being introduced.

Course Learning Objectives:

At the end of the internship / industrial training duration, a candidate will be able to
Obtain required exposure to industry / research centers.
Handle live problems in industry / research centers
Develop basic managerial skills in taking up technical research / industry related problems.

Course Outcomes (COs):

At the end of the internship / industrial training duration, a candidate would have

1) Acquired exposure to industry / research centers. [PO1,PO2,PO3,PO4 & PO5]
2) Handle live problems in industry / research centers. [PO1,PO2,PO3,PO4 & PO5]
3) Developed basic managerial skills for taking up technical research / industry related problems. [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Evaluation	100	CO-1 & CO-2, CO-3

PROJECT WORK – I	
Course Code: RAIP34	**Credits: 0:0:4**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Dr. Jaya Christiyan K G	

Workflow

During the III Semester, through literature survey and discussion with the supervisor allotted by the department, the candidate would have formulated a research problem. During the Phase II, based on the problem formulation, experimentation will be carried out, followed by results and discussion. As a last part of the project work, in Phase III, the candidate shall prepare a project report in bound form and submit the same to the department, with due certification by the supervisor.

Course Outcomes (COs):

1. The candidate would have applied the technical knowledge learnt to prepare a methodology to solve the research problem formulated. [PO1,PO2,PO3,PO4 & PO5]
2. The candidate would have conducted the experiments / analytical solutions according to the standards acceptable by the peers, and will be able to demonstrate and analyze results obtained. [PO1, PO2, PO3, PO4 & PO5]
3. The candidate would have prepared a comprehensive report of the project work. (a technical article in peer reviewed journals) [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Seminar – I	50	CO-1 &CO-2
Seminar – II	50	CO-3
Average of the two seminars will be considered for evaluation of 50 Marks		
General Seminar - 50 Marks		
General Seminar	50	CO-1,CO-2, CO-3

PROJECT WORK – II	
Course Code: RAIP41	**Credits: 0:0:20**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Dr. Sunith Babu L	

Preamble:
The candidate should be able to effectively, orally present a seminar on the project work executed during the III and IV semesters. The same shall be evaluated by a panel of examiners recommended by the department.

Course Learning Objective:

1. To prepare a suitable computer aided slides on the project work carried out
2. To present orally the details of the project work carried out.
3. To prove the ability to defend questions arising out of the project work with respect to correctness and acceptability

Course Outcomes (COs):

1. The candidate will have prepared suitable computer aided presentation on the project work carried out [PO1,PO2PO3,PO4 & PO5]
2. The candidate will be able to present orally the details of the project work carried out. [PO2,PO3,PO4 & PO5]
3. The candidate will be able to prove the ability to defend questions arising out of the project work with respect to correctness and acceptability [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Seminar – I	50	CO-1 &CO-2
Seminar – II	50	CO-3
Average of the two seminars will be considered for evaluation of 50 Marks		
SEE Final Evaluation- 50 Marks		
Final Evaluation (Internal and External Guide)	100	CO-1,CO-2, CO-3

SOFT COMPUTING	
Course Code: RAIE131	**Credits: 4:0:0**
Prerequisite: Data Structures, Optimization Techniques	**Contact Hours: 56**
Course Coordinator: Dr. Jagadeesh	

Course Contents

Unit I

Introduction: Neural networks, Fuzzy logic, Genetic algorithms, Hybrid systems, **Artificial Neural Networks:** Fundamental concept, Evolution, Basic model of ANN, Important terminologies of ANN, MP neuron, Hebb Network.

Unit II

Supervised Learning Network: Perceptron Networks, Adaptive linear neuron, multiple adaptive linear neurons, Back propagation Network.

Unit III

Introduction to Fuzzy logic, classical sets and fuzzy sets: Classical sets, Fuzzy sets. **Classical relations and fuzzy relations:** Cartesian product of relation, Classical relation, Fuzzy relations, Tolerance and equivalence relations. **Membership functions:** Features, Fuzzification, methods of membership value assignments.

Unit IV

Defuzzification: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations, Defuzzification methods.Fuzzy decision making: Individual, multiperson, multiobjective, multiattibute, and fuzzy Bayesian decision making.

Unit V

Genetic algorithms: Introduction, Basic operations, Traditional algorithms, Simple GA, General genetic algorithms, The schema theorem, Genetic programming, applications.

Text Book:

1. Principles of Soft computing, S N Sivanandam, Deepa S. N, Wiley, India, (Chapters 1, 2, 3(Up to 3.5), 7, 8, 9, 10, 13, 15 (up to 15.6 & 15.9,15,10)

Reference Book:

1. Neuro-fuzzy and soft computing, J.S.R. JANG, C.T. SUN, E. MIZUTANI, PHI (EEE edition) ISBN: 978-81-203-2243-1

Course Outcomes (COs):

This course will help students to achieve the following objectives:

1. Identify and describe soft computing techniques and their roles in building intelligent machine. [PO1, PO2, PO3, PO4, PO5]
2. Identify the components and building block hypothesis of Genetic algorithm [PO1, PO2, PO3, PO4, PO5]
3. Examine the features of neural network and its applications. [PO1, PO2, PO3, PO4, PO5]
4. Design Genetic algorithm to solve optimization problem. [PO1, PO2, PO3, PO4, PO5]
5. Describe Neuro-Fuzzy system for clustering and classification and Recognize the feasibility of applying a soft computing methodology for a particular problem [PO1, PO2, PO3, PO4, PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ROBOT SYSTEM DESIGN	
Course Code: RAIE132	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 42**
Course Coordinator: Dr. Girish V Kulkarni	

Course Content

Unit I

Introduction

Introduction to Mechanical Engineering Design, phases of design process, design consideration, design tools and resources, design engineers responsibilities, codes and standards, safety and product liability, stress and strength, design factor and factor of safety, reliability.

Materials

Material strength and stiffness, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, Factor of safety, True stress and strain, hardness, ferrous, non-ferrous, plastics and composite materials.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links:https://www.youtube.com/watch?v=wG2MBL-NqeM&list=PLGiGNMkNq6Qu7h6mgBe1LdXEWCRtVhjBA

Unit II

Design Calculation - Calculation of stresses in straight, Stepped and tapered sections, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=ukfNnt8abPo

Unit III

Static Strength, Static loads, Theories of elastic failure – Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials, Stress concentration factor

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=qbv2rOEMyiA

Unit IV

Spur Gears - Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear.

Gear Trains - Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=2aftYe1sAuk

Unit V

Belt Drives - Belt Drives, types – flat and v belt, materials, ratio of tensions, centrifugal stress in a belt, Power transmitted, effect of centrifugal tension on power transmitted, Simple numerical problems

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation
- Links: https://www.youtube.com/watch?v=j6woGQdUPFs&t=191s

Text Book:

1. Shigley's Mechanical Engineering Design, McGraw-Hill Series in Mechanical Engineering - Richard Budynas, Keith Nisbett, ISBN - 9780073398204, Publisher - McGraw-Hill Education.

Reference Book:

1. Design of Machine Elements, V B Bhandari, Fifth Edition, ISBN - 978-9390177479, Publisher, McGraw Hill

Course Learning Outcomes (COs):

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

1. Selection of suitable materials for robotic applications [PO1, PO2, PO3, PO4, PO5]
2. Establish design calculations for straight and tapered bars [PO1, PO2, PO3, PO4,P O5]
3. Identify the failure of a ductile and brittle materials [PO1, PO2, PO3, PO4, PO5]
4. Establish the parameters in design of spur gears [PO1, PO2, PO3, PO4, PO5]
5. Select suitable belt drives for power transmission. [PO1, PO2, PO3, PO4, PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	Marks	Course outcomes addressed
Internal test-I	30	CO-1 & CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 & CO-5

SENSORS AND ACTUATORS FOR ROBOTICS	
Course Code: RAIEXX1	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Mr. Bharath M R	

Course Content

Unit I

Introduction:

Manufacturing applications of photo detectors, detection methods through beam detection, Reflex detection & Proximity detection. Applications of inductive and capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=gPosu0j9ZUQ

Unit II

Advanced sensor technology

Identification of manufacturing components, bar code, transponder, electro-magnetic identifier, surface acoustic waves, optical character recognition, and fuzzy logic for opt-electronic colour sensor in manufacturing, Sensing principles, colour theory, unit colour measurement, colour comparator, colour sensing algorithm, design in fuzzy logic colour sensor.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=ZSiXZxVpVhs

Unit III

Sensors in FMS

Vision sensors, image transformations, robot visual sensing tasks, edge detection & extraction, Detecting partially visible objects, cryogenic manufacturing applications, measurement of high temperature, multi sensor, control robot assembly, collection & generation of process signals in decentralized manufacturing system

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=YoslM2Sxihs

Unit IV

Actuators - Introduction:

Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria.

Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator

- Pedagogy/ Course Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=LHn7O6PUaoY

Unit V

Fiber Optics in sensors and control systems

Introduction, Photoelectric sensors-long-distance detection, Fiber optics, types of fiber optics, optical fiber parameters, factors affecting the selection of position sensors, sensor alignment techniques, principal of fiber optics in communication, configuration of fiber optics, flexibility and testing of fiber optics, applications of fiber optics.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=2mgc7AX2piM

Text Books:

1. Sabne soloman, sensors & control systems in manufacturing. Mc-Graw Hill book Company Network, 1994.
2. N.L.Buck & T.G.Buckwith, Mechanical measurement, Addison Wesley Publishing Co.1973.

References Books:

1. Doebelin, Measurement systems: Applications & design, International Student Edition, 1974

Web Links and E Resources:

1. https://archive.nptel.ac.in/courses/108/108/108108147/

Course Outcomes (COs):

1. To analyze the need for applications and advancements with the use of sensors and Control systems. [PO1,PO3,PO4, PO5]
2. To analyze the concept of advanced sensor technology consisting of the newer technologies and components used for identification of manufacturing components, like bar code, transponders, color sensing, etc.[PO1,PO2,PO3, PO4, PO5]
3. To apply the advanced techniques of sensors in flexible manufacturing system, such as image transformation, robot visual sensing tasks, detecting partially visible objects, robot assembly control etc.[PO1,PO2,PO3,PO4,PO5, PO6, PO8 & PO10]
4. To analyze the working of various types of actuators [PO1,PO2,PO3,PO4 & PO5]
5. To analyze the concepts of fiber optics in sensors and control systems with various industrial applications [PO1,PO3,PO4,PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

COMPUTER AIDED DESIGN	
Course Code: RAIEXX2	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Mr. Bharath M R	

Course Content

Unit I

Introduction to CAD:

Definition, Product cycle and CAD/CAM, Automation & CAD/CAM Computer Graphics and Database: Introduction, Software configuration of a Graphic system, Functions of graphics package, Constructing the Geometry, Database structure and Content, Wire frame features. Computer Aided Design System Hardware Introduction, Generative design, topology optimization.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: Introduction to CAD https://www.youtube.com/watch?v=KBANsPhXaIE
  Generative Design and topology optimization
  https://www.youtube.com/watch?v=QLA92V_85_I

Unit II

Graphic Interface and CAD/CAM Cloud:

CAD System Configuration, Computer Aided System Software: Introduction, Operating system, Graphics system. Graphics Database structure and Handling, Data Selection, Graphic transformation, Plotting, Graphic standards. Cloud Based CAD/CAM tools.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=EPwOgh-M_ok

Unit III

Transformation Systems:

Display, Windowing and Clipping, Two-dimensional transformations, Three-dimensional transformations, linear transformations, problems on Two-dimensional Transformations

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: 2D transformations https://www.youtube.com/watch?v=hpOlzSRcr0w

Unit IV

Geometric Modelling - Introduction:

Dimensions of models, Types of models, Construction of solid models, Wire frame models, Curve representation. Parametric representation of analytic curves – Lines, Circles, Ellipse, Parabolas, Hyperbolas, Conics. Parametric representation of Synthetic Curves – Hermite Cubic Splines, Bezier Curves, B-Spline Curves, Rotational Curves. Surface Models: Introduction – Surface models, Surface Entities, Surface Representation. Parametric Representation of Analytic Surface – Plane surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Parametric representation of Synthetic surface, Bezier Surface, B- Spline surface, Coons Surface.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/results?search_query=introduction+to+parametric+representation+of+curves

Unit V

Interpretation & Applications of CAD in Robotics:

Curve Segmentation, Trimming, Intersection & Projection. Mechanical Assembly: Introduction, Assembly modelling – Parts modelling and Representation, Hierarchical Relationship, Mating Conditions. Inference of position from mating conditions. Versatility of Applications of CAD in robotics – Case Studies.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=EDTMcSQkVNI
  https://www.youtube.com/watch?v=DknClgFx8rU

Text Books:

1. M P Groover and Zimmer, CAD/CAM Computer Aided Design and Manufacturing, Prentice hall 2000.
2. CAD/CAM Ravindra A.S Best Publishers 2005.

Reference Books:

1. C B Besant and CWK Lui – Computer Aided Design and Manufacturing, Affiliated East West, India 1988.
2. Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill 1988.

Web Links and E Resources:

1. https://nptel.ac.in/courses/112102101
2. https://nptel.ac.in/courses/106102065
3. https://www.digimat.in/nptel/courses/video/111104095/L01.html
4. https://nptel.ac.in/courses/107103012
5. https://archive.nptel.ac.in/courses/107/103/107103012/

Course Outcomes (COs):

1. Demonstrate basics of product cycle, CAD system software and hardware, CAD Database, graphic standards, Mechanical assembly and inferences to be drawn from an assembly. [PO1,PO2,PO4 & PO5]
2. Illustrate basics of graphic transformations and graphic representations and exhibit the knowledge of working on a CAD user interface. [PO1,PO2,PO4 & PO5]
3. Solve math based problems using graphic transformation and graphic representation. [PO1,PO2,PO3,PO4 & PO5]
4. Analyze the geometrical entities with respect to their parametric representation. [PO1,PO2,PO3,PO4 & PO5]
5. Evaluate the detailed hierarchical condition of an assembly model and represent them graphically[PO1,PO2,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

INTERNET OF THINGS FOR ROBOTS	
Course Code: RAIEXX3	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours:**
Course Coordinator: Mr. Nandeesha H L	

Course Content

Unit I

INTRODUCTION: Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

DESIGN OF IoT : Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=Fj02iTrWUx0&t=105s&pp=ygUTaW50cm9kdWN0aW9uIHRvIGlvdA%3D%3D
  https://www.youtube.com/watch?v=WUYAjxnwjU4&pp=ygUTaW50cm9kdWN0aW9uIHRvIGlvdA%3D%3D

Unit II

SMART OBJECTS OF ROBOT: The "Things" in robot, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. Application Protocols for IoT

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=ubdThCBIS_8&pp=ygUUU01BUlQgT0JKRUNUUyBvZiBpb3Q%3D
  https://www.youtube.com/watch?v=ubdThCBIS_8&pp=ygUUU01BUlQgT0JKRUNUUyBvZiBpb3Q%3D

Unit III

PROTOTYPING OF IoT ROBOT : Design principles for connected devices -Embedded devices, physical design, online components. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics robot, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Energy management and resource optimization, proactive maintenance. IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking)for robot.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=mJS8A8TtC9M&pp=ygUTUFJPVE9UWVBJTkcgT0YgSW9UIA%3D%3D
  https://www.youtube.com/watch?v=quqejxmkLck&pp=ygUTUFJPVE9UWVBJTkcgT0YgSW9UIA%3D%3D

Unit IV

INTERNET OF ROBOTIC THINGS: Current Technologies, cloud robotics, Space and defence applications, Challenges and Future Directions.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=atXaD9fDzac&pp=ygUaSU5URVJORVQgT0YgUk9CT1RJQyBUSElOR1M%3D
  https://www.youtube.com/watch?v=it9FC52m8w&pp=ygUaSU5URVJORVQgT0YgUk9CT1RJQyBUSElOR1M%3D

Unit V

APPLICATION IN MANUFACTURING : Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=wspWyKbqY7A&pp=ygUhaW90IGFwcGxpY2F0aW9ucyBpbiBtYW51ZmFjdHVyaW5n
  https://www.youtube.com/watch?v=7hP5RBGdlnI&pp=ygUhaW90IGFwcGxpY2F0aW9ucyBpbiBtYW51ZmFjdHVyaW5n

References Books:

1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley &Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence” Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.
6. Carlos, Bruno, Georges Bastin, “Theory of Robot Control”, Springer, 2012
7. R Kelly, D. Santibanez, LP Victor and Julio Antonio, “Control of Robot Manipulators in Joint Space”, Springer, 2005.

Course Outcomes (COs):

After completing this course, students will be in

1. Position to understand various building blocks and working of state-of-the-art IoT systems. [PO1,PO2,PO3,PO4 & PO5]
2. Gain better knowledge about wireless technology and control system. [PO1,PO2,PO3,PO4 & PO5]
3. Easy management of robot resources for particular application by using suitable sensors and IoT from anywhere. [PO1,PO2,PO3,PO4 & PO5]

4. Students would also gain enough insights to conceive and build IoT robots on their own**.** [PO1,PO2,PO3,PO4 & PO5]
5. The typical use cases of IoT robots are wearables, smart homes, smart vehicles, traffic prediction & control weather monitoring & forecasting, indoor location-based services, health monitoring of machines & structures. [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ROBOT OPERATING SYSTEM (ROS)	
Course Code: RAIEXX4	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Sunith Babu L	

Course Content

Unit I

Introduction to ROS

Introduction to ROS: Introduction to Robot Operating System (ROS), History and background of ROS, ROS architecture and components, Installation and setup of ROS, Navigating the ROS documentation, Basic ROS concepts and terminology.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=96XsJ7xfsS8

Unit II

ROS Tools and Command Line Usage

Introduction to ROS tools: roscore, roslaunch, rosrun, etc., Using command line tools for basic operations, Working with topics: viewing and publishing data, Interacting with services and messages, nodes and communication

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/XowX34zg2xw

Unit III

Working with Robots in ROS

Working with Robots in ROS : Introduction to robot models and simulations, Using existing robot models and packages, Visualizing robots in RViz, Basic robot control with teleoperation,
Simulating robot motion with ROS tools

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/8QfI5a7lTKU

Unit IV

ROS Packages and Visualization

Introduction to ROS packages: Structure and organization, Using pre-existing ROS packages for various functionalities, Visualizing data with RViz and rqt tools, Basic ROS data visualization techniques, Customizing visualization settings in ROS

- Pedagogy/ Course: Chalk and talk, Power point presentation
- Links: https://youtu.be/yXDwXhB5QgA

Unit V

BASIC ROS APPLICATIONS AND PROJECT

Basic ROS Applications and Project: Introduction to ROS application development, creating a simple ROS application, and Understanding the ROS file structure. Building a basic robot control system, Completing a small-scale ROS project

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://youtu.be/DBFYZRMLr70

Text Books:

1. ROS Robotics Projects, Lentin Joseph, Packt Publishing, March 2017, ISBN – 9781783554713
2. Programming Robots with ROS: A Practical Introduction to the Robot Operating System" O'REILLY, by Morgan Quigley, Brian Gerkey, and William D. Smart, ISBN – 978-1449323899

References books:

1. YoonSeok Pyo, HanCheol Cho, Ryu Woon Jung, TaeHoon Lim, ROS Robot Programming, Robotics 2017
2. AnisKoubaa, Robotics Operating System (ROS) – The Complete Refernece (vol 3) Springer 2018
3. Wyatt Newman, A Systematic Approach to Learning Robot Programming with ROS CRC Press, ISBN – 978 – 1498777827, Chapman and Hall

Course Outcomes (COs):

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

1) Gain a foundational understanding of Robot Operating System (ROS) and its key components [PO1, PO3, PO4, PO5]
2) Discuss effectively the use ROS command line tools, work with topics, services, and message[PO1, PO3, PO4, PO5]
3) Work with robot models, utilize existing packages, visualize robots in RViz [PO1, PO3, PO4, PO5]
4) Analyse the structure of ROS packages, utilize pre-existing packages for various functionalities [PO1, PO3, PO4, PO5]
5) Develop a basic ROS application [PO1, PO3, PO4, PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ADDITIVE MANUFACTURING	
Course Code: RAIEXX5	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Jaya Christian	

Course Content

Unit I

ADDITIVE MANUFACTURING

Additive Manufacturing, The Generic AM Process, AM Information work flow, AM – An Integral Part of Time Compression Engineering, Classification of AM Processes, The Benefits of AM, Distinction Between AM and CNC Machining, Generalized Additive Manufacturing Process Chain. Vat Photopolymerization AM Processes: Introduction, Vat Photo polymerization Materials, Photo polymerization Process, **Extrusion-Based Systems**: Introduction, Basic Principles, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bio extrusion

- Pedagogy/Course delivery tools:Chalk and talk, Powerpoint presentation
- Links: **Introduction to AM** https://www.youtube.com/watch?v=ICjQ0UzE2Ao
- Links: **Vat Photo polymerization** https://www.youtube.com/watch?v=7jNodHYUQc8

Unit II

SOFTWARE

Software Issues for Additive Manufacturing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist AM.

Solid Ground curing: Introduction, Basic Principles, SGC Process, Materials. LOM, Binder Jetting Solid Porous Tissue Scaffolds by AM, Process Benefits and Drawbacks, Applications

- Pedagogy/Course delivery tools:, Chalk and talk, Power point presentation
- Links: **Solid Ground curing**, https://www.youtube.com/watch?v=ThwFB12cbnM

Unit III

DESIGN FOR ADDITIVE MANUFACTURING

Design for Additive Manufacturing: Design for Manufacturing and Assembly, Introduction to Design for Additive Manufacturing, General Guidelines for Designing AM Parts, Design to Avoid Anisotropy, Design to Minimize Print Time, Design to Minimize Post-processing. Take Advantage of Design Complexity, Use Topology Optimisation or Lattice Structures, Overhangs and Support Material.

Post-processing: Support Material Removal., Polymer Surface Treatments, Vapour Smoothing, Painting, Sand Blasting, Hydrographics, Tumbling, Dying, Metal Surface Treatments, Shot-Peening, Plasma Cleaning and Ion Beam Cleaning, Machining and Grinding, Anodizing, Plasma Spraying, Plating and PVD, Gluing and Welding AM Parts,

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: **Design for Additive Manufacturing**, https://www.youtube.com/watch?v=U0xxd70g0y0
- Links: **Post-processing**, https://www.youtube.com/watch?v=uuCt_8nGDrM

Unit IV

POWDER BED PROCESS

Powder Bed Fusion: Selective Laser Sintering Introduction, Process parameter, sintering in SLS Metal powders for laser sintering, Electron Beam melting (EBM) process.

Directed Energy Deposition Processes: Introduction, General DED Process Description, Material Delivery, DED Systems, Process Parameters, Typical Materials and Microstructure, Processing–Structure–Properties Relationships, DED Benefits and Drawbacks.

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: **Directed Energy Deposition Processes**, https://youtu.be/LjWL-lQe6ok

Unit V

DIRECT AND INDIRECT PROCESS

Indirect Methods for Rapid Tool Production, Role of Indirect Methods in Tool Production, Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Sand Casting

Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, DTM RapidToo1 process, Sand Form, Injection Moulds, Topographic Shape Formation, Pattern for Investment and Vacuum Casting, Functional Models.

- Links: Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- **Direct Methods for Rapid Tool**, https://youtu.be/RQVjwSG1-XY

Text Books:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, Fiham D.T & Dinjoy S.S Verlog London 2001.
4. Rapid Prototyping: Principles and Application, by Rafiq I. Noorani

Course Outcomes (COs):

1. The students will learn about a working principle and construction of Additive Manufacturing technologies [PO1,PO2,PO3,PO4 & PO5]
2. The students will potential to support design and manufacturing, modern development in additive manufacturing process [PO1,PO3,PO4 & PO5]
3. The student can assess and implement AM techniques for specific application leading to better ROI for the company that uses Laser AM machines [PO1,PO2,PO3,PO4 & PO5]
4. The students can enhance the production sequence of tooling process by choosing the correct material for the job[PO1,PO2,PO3,PO4 & PO5]
5. The students are in a position to incorporate the productivity sequence by choosing the right AM technology.[PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ROBOTIC PROCESS AUTOMATION	
Course Code: RAIEXX6	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. R. Kumar	

Course Content

Unit I

RPA FOUNDATIONS

RPA Foundations- What is RPA - history of RPA- The Benefits of RPA- The downsides of RPA- RPA Compared to BPO, BPM and BPA- Consumer Willingness for Automation- The Workforce of the Future- RPA Skills-On-Premise Vs. the Cloud- Web Technology- Programming Languages and Low Code- 0CR-Databases-APls- Al-Cognitive Automation.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: RPA , https://www.youtube.com/watch?v=9URSbTOE4YI

Unit II

RPA PLATFORM

RPA Platforms- Components of RPA- RPA Platforms-Ui Path - The future of automation - Record and PIay - Downloading and installing UiPath Studio -Learning UiPath Studio- - Task recorder - Step-by step examples using the recorder.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: RPA Platforms, https://www.youtube.com/watch?v=vmvrHNytEC4

Unit III

CONTROL FLOW

Sequence,Flowchart, and Control Flow-Sequencing the workflow- Activities-Control flow, various types of loops, and decision Making-Step-by -step example using Sequence and Flowchart, Step-by-step example using Sequence and Control Flow-Data Manipulation-Variables and Scope-Collections-Arguments - Purpose and Use-Data table usage with examples-
Clipboard Management-File operation with step-by-step example.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: UiPath Sequences vs Flowcharts, https://www.youtube.com/watch?v=SvtCj_SYj_8,

Unit IV

CONTROLS AND WORKING

Taking Control of the Controls- Finding and attaching windows- Finding the control- Techniques for waiting for a control- Act on controls - mouse and key board activities- Working with Explorer - Handling events- Revisit recorder- Screen Scraping- When to use OCR- Types of OCR available- H ow to use OCR- Avoiding typical failure points.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: OCR, https://www.youtube.com/watch?v=g1V6vyAvJtU

Unit V

ERROR ANALYSIS

Exception Handling, Debugging, and Logging- Exception handling- Common exceptions and ways to handle them- Logging and taking screenshots¬ Debugging techniques- Collecting crash dumps - Error reporting- Future of RPA.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: Future of RPA, https://www.youtube.com/watch?v=XnEUrj9rK7E

Text Books:

1. TomTaulli, The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems,2020, ISB N - 13 (electronic): 978-1-4842-5729 -6, Publisher: A press
2. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 ISBN: 9781788470940

Reference Books:

I. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston,Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation.
2. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant
3. Srikanth Merianda, Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation
4. https: / / www.u ipath.com /rpa / robotic-process-automation

Course Outcomes (COs):

The students should be able to:

1. To Understand the basic concepts of R PA
2. To Describe various components and platforms of RPA
3. To Describe the different types of variables, control flow and data manipulation techniques
4. To Understand various control techniques a n d OC R in R PA
5. To Describe various types and strategies to handle exceptions

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

MECHATRONICS & MEMS	
Course Code: RAIEXX7	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. R. Kumar	

Course Content

Unit I

MECHATRONICS, SENSORS AND TRANSDUCERS

Introduction to Mechatronics Systems, Measurement Systems Control Systems Microprocessor based Controllers. Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force,
Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors Selection of Sensors.

- Pedagogy/Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Lab component/Practical topics:, Arc Welding and soldering
- Links: Mechatronics, sensor, https://www.youtube.com/watch?v=-qdiHCmWi1U
- Links: Transducers , https://www.youtube.com/watch?v=nSeW3R2hr1A

Unit II

SIGNAL CONDITIONING

Introduction to signal conditioning. The operational amplifier, Protection, Filtering, wheat stone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation, Numerical problems

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: Signal conditioning , https://rb.gy/yuqp3

Unit III

ACTUATION SYSTEMS

Electrical Actuation Systems – Mechanical Switches – Solid State Switches, Solenoid Construction and working principle of DC and AC Motors speed control of AC and DC drives, Stepper Motors-switching circuitries for stepper motor – AC & DC Servo motors. Introduction to Hydraulic and Pneumatic actuation systems and their application.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: stepper motor, https://www.youtube.com/watch?v=f0vrTNmCTkc
- Links: servo motor, https://www.youtube.com/watch?v=ditS0a28Sko

Unit IV

MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

Introduction –MEMS, MEMS micro sensor, Mems micro actuator, manufacturing processes of MEMS, commonly used MEMS micro sensors, Advantages and applications of MEMS.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos,
- Links: MEMS sensor https://www.youtube.com/watch?v=eqZgxR6eRjo
- Links: MEMS-Manufacturing , https://rb.gy/uht0k

Unit V
PROGRAMMABLE LOGIC CONTROLLERS

Programmable Logic Controllers– Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers- Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC.
Home automation with the application of PLC.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Lab component/Practical topics:, Home automation
- Links: PLC https://www.youtube.com/watch?v=ReTtgzN-Dmc
- Links: PLC programming, https://www.youtube.com/watch?v=Qf32qtHfowQ

Text Books:

1. Mechatronics- W. Bolton, Longman, 2nd Pearson Publications, 2007
2. Microprocessor Architecture, programming and applications with 8085.8085A- R.S. Ganokar, Wiley Eastern.

Reference Books:

1. Mechatronics Principles & applications by Godfrey C. Canwerbolu, Butterworth- Heinemann 2006.
2. Mechatronics- DanNecsulescu, Pearson Publication, 2007
3. Introduction Mechatronics & Measurement systems, David. G. Aliciatore & Michael.B. Bihistand, tata McGraw Hill, 2000.
4. Mechatronics : Sabricentinkunt, John wiley& sons Inc. 2007

Web links and video lectures (e-Resources):

- https://www.youtube.com/watch?v=f0vrTNmCTkc
- https://www.youtube.com/watch?v=eqZgxR6eRjo
- https://www.youtube.com/watch?v=ReTtgzN-Dmc
- https://www.youtube.com/watch?v=Qf32qtHfowQ
- https://onlinecourses.nptel.ac.in/noc21_me27/preview

Course Outcomes (COs):

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

1. Define Mechatronics systems and recognize its various elements.
2. Compile the key signal conditioning circuits.
3. Demonstrate the concepts of system models and controllers.
4. Understand the concepts of programming logic controllers.
5. Understand the concepts of MEMS

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

COMPUTER AIDED PROCESS PLANNING	
Course Code: RAIEXX8	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Mr. BHARATH M R	

Course Content

Unit I

Introduction: Process Planning,

Approaches to process planning - Study of a typical process planning - role of process planning in CAD / CAM Integration-Concurrent Engineering, Part design Representation: Tolerance concepts - Geometric Tolerance

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=_oFoXyDBZyA

Unit II

Drafting Practices in Dimensioning and Tolerancing

Geometric Transformation - Data Structure - GT coding, DCLASS, OPITZ system, MICLASS system

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=G7wnGeR_69k

Unit III

Process Planning:

Decision tables and Decision Trees - Process Planning, Variant Process Planning, Generative Process planning – AI, Geometric modelling for Process Planning - Process Capability Analysis

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=xtghDoIDc_U

Unit IV

Computer Aided Process Planning Systems:

Logical Design of Process Planning - Manufacturing System component, Production Volume, Production families - CAM I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP, Genetic Algorithm and Integrated Process Planning systems

- Pedagogy/ Course Chalk and talk, Power point presentation
- Links: , https://www.youtube.com/watch?v=20_K7c65Swg

Unit V

Genetic algorithm in CAPP

Practical use of CAPP in real Manufacturing area, Expert systems, Fuzzy Logic in Process Planning, totally integrated process planning and Case study

- Pedagogy/ Course Chalk and talk, Power point presentation
- Links: , https://www.youtube.com/watch?v=__0nZuG4sTw

Text Books:

1. Rao, 'Computer Aided Manufacturing', Tata McGraw Hill Publishing Company, 2000
2. Nanua Singh, 'Systems approach to Computer Integrated Design and Manufacturing', John Wiley & sons, 1996

Reference Books:

1. Gideon Halevi and Roland. D. Weill, 'Principles of Process Planning, A logical approach', Chapman & Hall 1995
2. Tien - Chien Chang, Richard. A. Wysk, 'An introduction to Automated process planning system', Prentice Hall, 1985.

Web Links and E Resources:

1. https://archive.nptel.ac.in/courses/110/105/110105155/

Course Outcomes (COs):

1. Recognize and reproduce the concepts of CAPP. [PO1,PO2,PO3,PO4 & PO5]
2. Classify and summarize CAPP techniques for specific applications. [PO1,PO2,PO3,PO4 & PO5]
3. Apply and administer advanced planning software. [PO1,PO2,PO3,PO4 & PO5]
4. Breakdown and appraise stages of development in CAPP technology. [PO1,PO2,PO3, PO4 & PO5]
5. Reframe and conclude concepts of practical implementation of GT and coding. [PO1,PO2,PO3,PO4 & PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

FUNDAMENTALS OF DATA ANALYTICS USING R	
Course Code: RAIEXX9	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. M N Thippeswamy	

Course Content

Unit I

Overview of Data Analytics, Need of Data Analytics, Nature of Data, Classification of Data: Structured, Semi-Structured, Unstructured, Characteristics of Data, Applications of Data Analytics. D R Programming Basics Overview of R programming, Environment setup with R Studio, R Commands, Variables and Data Types, Control Structures, Array, Matrix, Vectors, Factors, Functions, R packages. Reading and getting data into R (External Data): Using CSV files, XML files, Web Data, JSON files, Databases, Excel files. Working with R Charts and Graphs: Histograms, Boxplots, Bar Charts, Line Graphs, Scatterplots, Pie Chart.

Unit II

MATRICES, ARRAYS AND LISTS: Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns: Adding and deleting rows and columns – Higher Dimensional arrays - Vector/Matrix Distinction – Avoiding Dimension Reduction - Characters and Strings - String vector - String operations and functions – List – Creating lists – General list operations – Accessing list components and values – applying functions to lists – recursive lists – Different R operations using a List, matrix, Array.

Unit III

Overview on Data Frames – Create it in scratch - Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames – Factors and Tables – factors and levels – Common functions used with factors – Working with tables - Math and Simulations in R - Reading a datafile directly into a dataframe - EDA using R - Reading different file formats.

Unit IV

S3 Classes – S4 Classes – Managing your objects – Input/Output – accessing keyboard and monitor – reading and writing files – accessing the internet – String Manipulation – Statistical analysis: Basic Statistics – Linear Model – Generalized Linear models – Non-linear models - R functions for statistical analysis - Graphics: Creating Graphs – Customizing Graphs – Saving graphs to files – Creating three-dimensional plots – interfacing: Interfacing R to other languages – Parallel R – Time Series and Auto-correlation – Clustering.

Unit V

Tidy Data with tidyr: Spreading and Gathering, Separating and Pull, Case Study, Nontidy Data, Relational Data with dplyr. LEARNING TECHNIQUES: Learning Techniques - Supervised Learning: Linear Regression; Logistic Regression; Decision Trees; Random Forests; K-Nearest Neighbours (k-NN); Supprt Vector Machine. Unsupervised Learning: K-Means Clustering; Hierarchical clustering.

Text Books:

1. Hadley Wickham & Garrett Grolemund, R for Data Science, O'Reilly, 2016.
2. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011
3. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
4. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013
5. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc, 2013.

Corresponding Online Resources:

- https://nptel.ac.in/courses/111104147

Course Outcomes (COs):

After completion of the course, students will be able to:

1. Describe the features of R Programming.
2. Use the various data structures in R.
3. Apply data frames, control statements and functions for the simulation.
4. Develop Oops based classes and apply graphic techniques.
5. Identify the statistical methods applied in R

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

HYDRAULICS AND PNEUMATICS	
Course Code: RAIEXX10	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Mohandas K N	

Course Content

Unit I

Introduction to Hydraulic Power: Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.

Hydraulic Actuators: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder Loading.

- **Pedagogy/Course delivery tools:** Chalk and talk, PowerPoint presentation
- **Links:** https://www.youtube.com/watch?v=m1NN_LAIMF4

Unit II

Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

Control Components in Hydraulic Systems: Directional Control Valves –Symbolic Representation, Constructional features, pressure control valves –direct and pilot operated types, Flow control valves.

- **Pedagogy/Course delivery tools:** Chalk and talk, PowerPoint presentation
- **Links:** https://www.youtube.com/watch?v=dPD8YuojtN0

Unit III

Hydraulic Circuit Design and Analysis: Control of single and double –acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, Accumulators.

- **Pedagogy/Course delivery tools:** Chalk and talk, PowerPoint presentation
- **Links:** https://www.youtube.com/watch?v=vEvNGr3mSxQ

Unit IV

Introduction To Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system.

Pneumatic Actuators: Linear cylinders –Types, conventional type of cylinder working, end Position cushioning, seals, mounting arrangements applications

- **Pedagogy/Course delivery tools:** Chalk and talk, PowerPoint presentation
- **Links:** https://www.youtube.com/watch?v=h-tzh8l1z-M&t=8s

Unit V

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, Basic pneumatic valves, Flow control valves and speed control of cylinders supply air throttling and exhaust air

throttling, use of quick exhaust valve. Pressure dependent controls types. Time dependent controls. Sensors

- **Pedagogy/Course delivery tools:** Chalk and talk, PowerPoint presentation
- **Links:** https://www.youtube.com/watch?v=rSG7llg3z7Y

Text Books:

1. Fluid Power with applications, Anthony Esposito, Fifth edition Pearson education, Inc. 2017.
2. Pneumatics and Hydraulics, Andrew Parr. Jaico Publishing Co. 2017.

Reference Books:

1. Oil Hydraulic Systems - Principles and Maintenance, S.R. Majumdar, Tata Mc Graw Hill Publishing company Ltd. 2012.
2. Pneumatic Systems, S.R. Majumdar, Tata Mc Graw Hill publishing Co., 2019.
3. Industrial Hydraulics, Pippenger, Hicks, McGraw Hill, New York, 2009

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 & CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 & CO-5

AUTONOMOUS MOBILE ROBOTS	
Course Code: RAIEXX11	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Sunith Babu L	

Course Content

Unit I

Locomotion – Introduction, Key Issues of Locomotion,
Legged Mobile Robots - Leg Configuration and Stability, Consideration of Dynamics, Examples,
Wheeled Mobile Robots – History of Wheeled Mobile Robots, The Design Space, Wheel Design, Wheel Geometry, Stability, Maneuverability, Controllability, Wheel Locomotion. Aerial Mobile Robots,

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: Robot Locomotion , https://www.youtube.com/watch?v=pj3ioPCYOjI
- Links: Wheeled Robots , https://www.youtube.com/watch?v=KH6DvvHFpdA

Unit II

Mobile Robot Kinematics: Introduction, kinematic models and constraints, mobile robot workspace, beyond basic kinematics, motion control (kinematic control).
Perception, robotics Architectures and Robot Learning: Sensors Classification, sensor characterization, wheel/motor encoders, heading/orientation sensors, ground based beacons, active ranging.

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: Robot Kinematics , https://www.youtube.com/watch?v=-DY2L8E4hJY
- Links: Robot Architecture , https://www.youtube.com/watch?v=YSj4cIFxvhc

Unit III

Mobile Robot Localization – Introduction, Challenge of Localization, Noise and Aliasing, To Localize or Not to Localize – Localization – Based Navigation Vs Programmed Solutions, Map Representation, Probabilistic Map-Based Localization, Autonomous Map Building,

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: Robot Localization , https://www.youtube.com/watch?v=FXowU7fwcuQ
- Links: Mobile Robot , https://www.youtube.com/watch?v=M0fL5Q6rGws

Unit IV

Navigation and Planning – Introduction, Competences for Navigation, Path Planning, Graph Search – Visibility Graph, Voronoi Diagram, Exact Cell Decomposition
Obstacle Avoidance – Bug0, Bug 1 and Bug 2 Algorithm, Popular Obstacle Avoidance Algorithm, Navigation Architecture

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: Navigation , https://www.youtube.com/watch?v=8sp5ZDbFq9Q
- Links: Obstacles Avoidance Robots , https://www.youtube.com/watch?v=mfmTB_5Geug

Unit V

Mobile Robot Maneuverability – Introduction, Degree of Mobility, Degree of Steerability, Robot Maneuverability, Simple Problems.

Applications - AMR's Applications, Goods to Person Picking, Self-driving Forklifts, Autonomous Inventory Robots, UAV's, Security, Healthcare, Benefits of AMR's, Manufacturing, Warehousing, Retail Banking, Hospitality, Logistics, Smart Cities, Agriculture, Special Applications - Bettybot, Roomba Vacuum Cleaner, Spot Mini

- Pedagogy/Course delivery tools:, Chalk and talk, Powerpoint presentation
- Links: Robot configuration , https://www.youtube.com/watch?v=a4ca04wG-cA
- Links: Manueuverability , https://www.youtube.com/watch?v=kN9a7W_hnSQ

Text Book :

1. Introduction to Autonomous Mobile Robots Roland Siegwart, Illah Reza Nourbakhsh etc.

Reference Book :

1. Wheeled Mobile Robotics. From Fundamentals Towards Autonomous Systems Gregor Klančar, Andrej Zdešar etc.

Course Learning Outcomes (COs):

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

1. Provide suitable solutions related to legged and wheeled robots for specific applications[PO1, PO2, PO3, PO4, PO5]
2. Develop kinematic workflow for the mobile robots [PO1, PO2, PO3, PO4, PO5]
3. Provide solutions for the mobile robot localization [PO1, PO2, PO4, PO5]
4. Develop mobile robot obstacle avoidance algorithm [PO1, PO2, PO3, PO4, PO5]
5. Identify the mobile robot maneuverability index for a specific developed robot. [PO1, PO2, PO3, PO4, PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

INDUSTRIAL & COLLABORATIVE ROBOTS	
Course Code: RAIEXX12	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. Sunith Babu L	

Course Content

Unit I

Industrial Robot Automation - Introduction, Justifying Robotic Automation, Benefits of Implementing Industrial Robot

Implementation of Robot Automation - Introduction, Team Effort, Anatomy of Robot Application - Machine Tending, Welding, Palletization, Material Removal Rate, Press Tending, Robot Size, Reach and Configuration, Judging Good and Bad Project. Gathering Right Criteria, constants and variables of a robot system

- **Pedagogy/Course delivery tools:** Chalk and talk, Powerpoint presentation
- **Links:** Industrial Robot Automation https://www.youtube.com/watch?v=s-yne8xTNM0&t=72s

Unit II

Industrial Robots – Introduction Definition, Articulated Robot, SCARA Robot, Delta Robots, Cartesian Robot, Polar Robot, Cylindrical Robot – Introduction, Specifications - Technical Specifications, Working Principle, Work Volume, Configuration, Applications (For above mentioned Robots). System Integration for an Industrial Robot.

- **Pedagogy/Course delivery tools:** Chalk and talk, Powerpoint presentation
- **Links:** SCARA Robot https://www.youtube.com/watch?v=-m1oKuFkSTE

Unit III

Economic Analysis – Introduction, Data Required, Methods of Analysis, Simple Payback Period, Production Rate Appraisal Payback, ROI Evaluation, Net Present Value, Robot Installation, Quality of Working Life, Attitude Towards Robots, Effect of Employment, Current Capabilities of Robot, Future Capabilities of Robots

- **Pedagogy/Course delivery tools:** Chalk and talk, Powerpoint presentation
- **Links:** Economics of Robot https://www.youtube.com/watch?v=IwT30VOD8K8

Unit IV

Collaborative Robot – Introduction, Definition, Safety Standards ISO 10218, RIA TS 15066, Collaborative Workspace, Types of Cobots, Bio-Mechanical Limits, Transient and Quasi Static Impact, ABB-Yumi, FANUC-CR, KUKA- LBR IIWA, UNIVERSAL ROBOTS - UR3/UR5/UR10/e Series, Advantages

- **Pedagogy/Course delivery tools:** Chalk and talk, Powerpoint presentation
- **Links:** https://www.youtube.com/watch?v=Sb6JjH3Kn34&t=147s

Unit V

Applications of Cobots - Assembly, Dispensing, Machine Tending, Material Handling, Welding, Polishing, Material Removal, Quality Inspection, Food and Beverages, Palletization, Case Studies

- Pedagogy/Course delivery tools: Chalk and talk, Powerpoint presentation
- Link**s:** Applications https://www.youtube.com/watch?v=BE6lbnfDdrU

Text Book :

1. Industrial Robotics How to Implement the Right System for Your Plant (Andrew Glaser) Industrial Press, New York, ISBN 978-0-83 1 1-3358-0, 2009

Course Learning Outcomes (COs):

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

1. Identify and implement robot automation based on applications. [PO1, PO2, PO3, PO4,PO5]
2. Develop work volume based on the application and provide solutions based on standard robot. [PO1, PO2, PO3, PO4,PO5]
3. Provide an economic analysis of the identified robot solutions and industry needs. [PO1, PO2, PO3, PO4,PO5]
4. Identify the different collaborative robots used in the industry and enable them to suggest appropriate solutions [PO1, PO2, PO3, PO4,PO5]
5. Provide suitable information related to application of cobots in different fields of engineering, medicine, manufacturing. [PO1, PO2, PO3, PO4,PO5]

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

INDUSTRIAL & COLLABORATIVE ROBOTS	
Course Code: RAIEXX13	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. GIRISH V KULKARNI	

Course Content

Unit I

Introduction: Position, Representation of Positions, Cartesian coordinates, Cylindrical coordinates, Spherical coordinates, Linear Velocity, Representation of Linear Velocities, Cartesian Coordinates, Cylindrical Coordinates, Spherical Coordinates, Rotation, Rotation Matrices, Active vs. Passive Rotation, Passive Rotation, Active Rotation, Elementary Rotations, Composition of Rotations, Representation of Rotations

- Pedagogy/Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: , https://www.youtube.com/watch?v=_BJAa9bCA3g
- Links: , https://www.youtube.com/watch?v=tOX0p87jb1k

Unit II

Kinematics of Systems of Bodies: Generalized Coordinates and Joint Configuration, Task-Space Coordinates End-Effector, Configuration Parameters, Operational Space Coordinates, Forward Kinematics, Differential Kinematics and Analytical Jacobian Position and Rotation Jacobian, Dependency on Parameterization Geometric or Basic Jacobian, Addition and Subtraction of Geometric Jacobians Calculation of geometric Jacobian using Rigid Body Formulation, Relation between Geometric and Analytic Jacobian Matrix, Kinematic Control Methods

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos, Demonstration using IC engine models
- Links: https://www.youtube.com/watch?v=AhSqSbxuu8Y
- Links: https://www.youtube.com/watch?v=0jokZ9FkjhY&vl=en

Unit III

Floating Base Kinematics: Generalized Velocity and Acceleration, Forward Kinematics, Differential Kinematics of Floating Base Systems, Contacts and Constraints, Point Contacts – Quadruped, Extended Contacts – Humanoid, Support Consistent Inverse Kinematics

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://www.youtube.com/watch?v=VjsuBT4Npvk
  https://www.youtube.com/watch?v=x7tkStus80U

Unit IV

Dynamics: Introduction, Foundations from Classical Mechanics, Newton's Law for Particles, Virtual Displacements, Virtual Displacement of Single Rigid Bodies, Virtual Displacement of Multi-Body Systems, Principle of Virtual Work, Newton-Euler Method, Newton-Euler for Single Bodies, Newton-Euler for Multi-Body Systems Lagrange Method.

- Pedagogy/ Course delivery tools:, Chalk and talk, Power point presentation, animated videos
- Links: , http://manipulation.csail.mit.edu/trajectories.html

Unit V

Dynamics of Floating Base Systems

Contact Forces, Soft Contact Model Contact Forces from Constraints, Constraint Consistent Dynamics, Contact Switches and Impact Collisions, Impulse Transfer Energy Loss, Joint-space Dynamic Control, Joint Impedance Regulation, Gravity Compensation, Inverse Dynamics Control, Task-space Dynamics Control

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links: https://www.youtube.com/watch?v=NRgNDlVtmz0
- Links: https://www.youtube.com/watch?v=mO7JJxaVtkE

Text Books:

1. Robot Dynamics Lecture Notes, Robotic Systems Lab, ETH Zurich
2. **Haim Baruh**. **Analytical Dynamics**. WCB/McGraw-Hill Boston, 1999. ISBN 0073659770.
3. **S. R. Buss.** Introduction to inverse kinematics with Jacobian transpose, pseudoinverse and damped least squares methods. Technical report, 2004. URL http://math.ucsd.edu/˜sbuss/ResearchWeb.

Reference Books:

1. **Jerry Pratt, Chee-Meng Chew, Ann Torres, Peter Dilworth, and Gill Pratt**. Virtual model control: An intuitive approach for bipedal locomotion. International Journal of Robotics Research (IJRR), 20(2):129–143, 2001. doi: 10.1177/02783640122067309. URL http://dx.doi.org/10.1177/ 02783640122067309.
2. **Bruno Siciliano and Oussama Khatib**. Springer Handbook of Robotics. Springer Berlin Heidelberg, Berlin, Heidelberg, 2008. ISBN 978-3-540-23957-4. doi: 10. 1007/978-3-540-30301-5. URL http://link.springer.com/10.1007/ 978-3-540-30301-5.
3. **Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo**. Robotics - Modelling, Planning and Control. Advanced Textbooks in Control and Signal Processing. Springer London, London, 2009. ISBN 978-1-84628-641-4. doi: 10. 1007/978-1-84628-642-1. URL http://link.springer.com/10.1007/ 978-1-84628-642-1.

Course Outcomes (COs):

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

1. Acquire knowledge on coordinate and rotation systems of the robot. (PO1, PO2, PO3, PO4, PO5)
2. Understand the kinematics of the system bodies. (PO1, PO2, PO3, PO4, PO5)
3. Study the floating base kinematics (PO1, PO2, PO3, PO4, PO5)
4. Understand the dynamics from the classical mechanics (PO1, PO2, PO3, PO4, PO5)
5. Analyze the floating base dynamics. (PO1, PO2, PO3, PO4, PO5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

INTRODUCTION TO DEEP LEARNING	
Course Code: RAIEXX14	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: -	

Course Content

Unit I

Introduction: What is a Neural Network? The Human Brain, Models of a Neuron, Neural Networks Viewed as Directed Graphs, Feedback, Network Architectures, Rosenblatt's Perceptron: Introduction, Perceptron, The Perceptron Convergence Theorem, Relation Between the Perceptron and Bayes Classifier for a Gaussian Environment. Reinforcement Learning.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=kgXJc68RgiA

Unit II

Multilayer Perceptrons: Introduction, The Back-Propagation Algorithm, XOR Problem, Heuristics for Making the Back-Propagation Algorithm Perform Better, Back Propagation and Differentiation. Backpropagation using MNIST.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: deep learning https://www.youtube.com/watch?v=6M5VXKLf4D4

Unit III

Convolution neural networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Efficient Convolution Algorithms, Convolutional Networks and the History of Deep Learning, Convnet with Tensorflow. Region based CNN.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=YRhxdVk_sIs

Unit IV

Sequence Modelling: Recurrent and Recursive Nets: Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and Other Gated RNNs, RNN with Tensorflow. Sentiment classification using LSTM.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links:https://www.youtube.com/watch?v=Mubj_fqiAv8&list=PLeo1K3hjS3uu7CxAacxVndI4bE_o3BDtO

Unit V

Paper Review and Implementation: Selection of two state-of-the-art papers (recent) on deep learning, in depth study of the papers in class and their implementation. Transfer learning.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation
- Links: https://www.youtube.com/watch?v=yofjFQddwHE

Text Books:

1. Simon Haykin, Neural networks and Learning Machines, Third Edition, Pearson,
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press

References:

1. Neural Networks and Deep Learning by Michael Nielsen http://neuralnetworksanddeeplearning.com/

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

NATURAL LANGUAGE PROCESSING	
Course Code: RAIEXX15	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. M N Thippeswamy	

Course Content

Unit I

Introduction: Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithms; Language, Thought, and Understanding; The State of the Art and The Near- Term Future; Regular Expressions and Automata; Morphology and Finite-State Transducers: Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=7-FZBgrW4RE

Unit II

N-grams: Counting Words in Corpora, Smoothing, N-grams for Spelling and Pronunciation, Entropy; Word Classes and Part-of-Speech Tagging: Part-of- Speech Tagging, Rule-based Part-of-speech Tagging, Stochastic Part-of-speech Tagging, Transformation-Based Tagging; Context-Free Grammars for English: Constituency, Context-Free Rules and Trees, Sentence- Level Constructions, The Noun Phrase.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=XQryJvocnK4

Unit III

Parsing with Context-Free Grammars: The Earley Algorithm; Features and Unification: Feature Structures, Unification of Feature Structures, Features Structures in the Grammar, Implementing Unification, Parsing with Unification Constraints; Lexicalized and Probabilistic Parsing: Probabilistic Context-Free Grammars, Problems with PCFGs.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=9GIgYd1OWfQ

Unit IV

Representing Meaning: First Order Predicate Calculus, Some Linguistically Relevant Concepts, Related Representational Approaches, Alternative Approaches to Meaning; Semantic Analysis: Syntax-Driven Semantic Analysis, Attachments for a Fragment of English; Lexical Semantics: Relations Among Lexemes and Their Senses, WordNet: A Database of Lexical Relations, The Internal Structure of Words.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=EpyUdYaR2fQ

Unit V

Discourse: Reference Resolution, Text Coherence, Discourse Structure; Generation: Introduction to Language Generation, An Architecture for Generation; Machine Translation: Language Similarities and Differences, The Transfer Metaphor

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=0lent3mq6CE

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

COMPUTER VISION USING AI	
Course Code: RAIEXX16	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. M N Thippeswamy	

Course Content

Unit I

Introduction: Computer vision, Imaging modalities, Fundamental steps in image processing, Applications of computer vision. Digital Image Fundamentals: Image formation model, Sampling and quantization, Relationships between pixels. Mathematical tools used in image processing.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=7-FZBgrW4RE

Unit II

Spatial Filtering: Intensity transformation functions, Histogram processing (Histogram equalization, Histogram matching), Fundamentals of spatial filtering (Mechanics of spatial filtering, correlation and convolution), Smoothing spatial filters, Sharpening spatial filters.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=XQryJvocnK4

Unit III

Image Segmentation: Fundamentals, Detection of isolated points, line and basic edge, Thresholding, Region-based segmentation. Representation and Description: Representation (border following, chain codes, minimum-perimeter polygons) Boundary descriptors (simple descriptors, shape numbers), Region descriptors (simple descriptors, topological descriptors, texture).

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=9GIgYd1OWfQ

Unit IV

Object Recognition: What Should Object Recognition Do? Feature, Geometric and semantic questions, Patterns and pattern classes, Recognition based on decision- theoretic methods, Matching, Optimum statistical classifier, Neural networks.

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=EpyUdYaR2fQ

Unit V

Morphological Processing: Erosion and Dilation, Opening and closing, Hit-or-miss transform, Morphological algorithms (Boundary extraction, Hole filling, Extraction of connected components). Compression Techniques: Fundamentals, Compression methods (Huffman, Arithmetic, Run-length coding)

- **Pedagogy/Course delivery tools:** Chalk and talk, Power point presentation
- **Links:** https://www.youtube.com/watch?v=0lent3mq6CE

Text Book:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 3rd ed.,Pearson.
2. Computer Vision: A modern approach, D.A. Forsyth, J.Ponce, PearsonEducation, 2015

References:

1. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education,2001.
2. B. Chanda and D. Dutta Majumdar, “Digital Image Processing and Analysis”,PHI, 2003.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

FINITE ELEMENT METHOD FOR STRUCTURAL APPLICATIONS	
Course Code: RAIEXX17	**Credits: 4:0:0**
Prerequisite: Nil	**Contact Hours: 56**
Course Coordinator: Dr. M N Thippeswamy	

Course Content

Unit I

Introduction: Basic concepts of elasticity. Kinematic and static variables for various types of structural problems.

Elasticity fundamentals: State of stress and strain at a point, equations of equilibrium, compatibility conditions, elastic stress strain relations.

Plasticity fundamentals: Material models, yield criteria.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/WwgrAH-IMOk

Unit II

Review of fundamentals of FEM: Basic procedure, variational and weighted residual methods (no numericals), Potential energy.

Analysis of bar, truss and beam: Shape functions, load vectors, simple numericals.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/GHjopp47vvQ

Unit III

Steady state heat transfer: One dimensional heat transfer in thin fins.

Two dimensional analysis: Finite element formulation for CST and 4 node quadrilateral elements (no numericals). Axi-symmetric formulation triangular element (no numericals).

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/uXod5l-jNgk

UNIT - IV

Dynamic analysis of structures: analysis of undamped free vibrations, Lagrangean functional, Hamilton's principle, equation of motion spring mass system.

Eigen values and Eigen vectors: Mass matrix for 2 node bar element. Eigen values and Eigen vector for 2 node bar element problems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/rz0mRu-FKV0

Unit V

Higher order elements: Lagrangean interpolation functions for linear, quadratic and cubic bar, triangle and rectangle elements.

Nonlinear FEM: nonlinear problems such as material non linearity, geometric nonlinearity and material and geometric non linearity, analysis procedures.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos
- Links https://youtu.be/OIxenyV6zNs

Text Books:

1. Introduction to Finite Element in Engineering, RChandrupatla and Ashok Belegundu, Prentice Hall India Pub 2006.
2. Introduction to the finite element methods, J. N. Reddy
3. The Finite Element Methods in Engineering – S.S. Rao, Butter Worth Heinemann, Pub 2005.
4. Hybrid Modelling and Optimization of Manufacturing, Quiza R et.al, Springer –Verlag Berlin Heidelberg, Pub. 2012
5. Finite Element Analysis, S.S.BhaviKatti, New Age International Publishers, 2015

Reference Books:

1. Finite Element Analysis Theory & Programming - C S Krishnamurthy – Tata McGraw Hill, Pub 2000.
2. The Finite Element Method – Zienkiewicz, O C-Tata McGraw Hill, Pub 1979.

Course Outcomes (COs):

The student will be able to:

1. Understand basics of theory of elasticity, plasticity and mechanics of metal working.
2. Understanding the variational and weighted residual methods and solve problems on bar, beams, trusses.
3. Demonstrate ability and skill to solve problems of heat transfer and finite element formulation with 2D elements.
4. Demonstrate ability and skill to formulate equation of motion for spring mass system and solve problems of undamped free vibrations in bar structures.
5. Demonstrate the understanding of higher order elements and nonlinear FEM analysis

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Internal test-II	30	CO-1, CO-2, CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100 Marks		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5