NITTE EDUCATION TRUST | NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

Semester-I

Scheme of Teaching, Syllabus & Examinations

M.Tech. Robotics & Artificial Intelligence (RAI)

SUBMITTED TO

VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

(Effective from Academic year 2022 - 23)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022 - 23

M.Tech., Robotics & Artificial Intelligence (RAI)

Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	BSc	22MAT11	Mathematics for Modelling & Simulation	03	--	00	03	50	50	100	3
2	IPCC	22RAI12	Applied Mechatronics	03	02	00	03	50	50	100	4
3	PCC	22RAI13	Robotics- Analysis & Control	03	--	02	03	50	50	100	4
4	PCC	22RAI14	Artificial Intelligence & Machine Learning	02	--	02	03	50	50	100	3
5	PCC	22RAI15	Robot Operating Systems (ROS)	02		02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology & IPR	03	--	00	03	50	50	100	3
7	PCCL	22RAIL17	Robot Design and Control Laboratory	--	04	--	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	Suggested ONLINE Courses	Classes and Evaluation procedure are as per the policy of the online course providers							PP
TOTAL				**17**	**06**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course, AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads toemployable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.

3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

MATHEMATICS FOR MODELLING & SIMULATION			
Course Code	22MAT11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

Given a data set, students will be able to

- Analyze the data and fit various models to it
- Obtain the inference from the data models
- Perform simple simulation of the models
- Optimize the models as per the required objective

Module-1

Introduction: Why model? What's a good model? Model validation**.** Simple and complex models, simulation vs. modelling, stochastic vs. Deterministic. **Functions; modelling with linear functions:** Function definition; domain and range, Functions described by tables, graphs and formulas, Increasing and decreasing functions; local and absolute extrema, Concavity; inflection points, Average rate of change, Linear functions with applications, Slope-intercept and point-slope forms, Piecewise-linear functions with applications

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration using Matlab/Minitab/MS Excel/Tableau

Module-2

Fitting linear models to data, evaluating model error; the sum of squared errors, Interpreting the correlation coefficient. modelling with logarithmic functions; linear systems,

Fitting exponential models to data, Continuous compounding, Continuous growth and decay, Newton's law of cooling and heating, Logarithmic functions with applications, fitting logarithmic models to data, Matrices, representing a system of linear equations with a matrix equation, Solving linear systems via matrix equations

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration using Matlab/Minitab/MS Excel/Tableau

Module-3

Modelling with polynomial functions

Quadratic functions with applications, Projectile motion, Maxima and minima applications, fitting quadratic models to data, Interpreting the coefficient of determination, Polynomial functions of higher degree with applications, Polynomial interpolation, Fitting cubic and quartic models to data.

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration using Matlab/Minitab/MS Excel/Tableau

Module-4

Probabilistic models

Monte Carlo (Buffon's needle, profit vs**.** risk, Bernoulli trials, Poisson distributions) Markov Chain (fundamental matrix, steps to absorption, mean first passage time), Applications to the inventory problem, the queuing problem, genetics, gambling, and the Internet and Google's PageRank algorithm

Diffusion

Random walk. Central limit theorem. Formulating the diffusion equation (probability v.s. concentration). Numerical method.

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration using Matlab/Minitab/MS Excel/Tableau

Module-5

Optimization models: Constrained optimization; Lagrange multipliers; shadow price; linear programming, integer programming

Statistical Models (supervised and unsupervised learning)

How to build a model from big data? Regression; Classification; tradeoff between model complexity, bias, and variance; Cluster analysis, Principal Component Analysis.

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration using Matlab/Minitab/MS Excel/Tableau

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **30 Marks will be conducted with following weightages**
    a. MSE1-40% Marks
    b. MSE2-40% Marks
    c. MSE3-20% Marks
2. Two assignments each of **10 Marks** or **one Skill Development Activity of 20 marks** to attain the COs and POs

The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) Functions, Data, and Models, Gordon and Gordon, The Mathematical Association of America, 2010 (ISBN-10: 0-8838-5767-7; ISBN-13 978-0-88385-767-0).
(2) A first course in mathematical modeling, Giordano, F. R., Fox W. P., and Horton S. B. (2014)
(3) Numerical Analysis.. Burden, R. L. and Faires, J. D. (2004). Brooks Cole, 8th edition

Reference Books

(1) Discrete mathematical models.. Roberts, F. S. (1976). Prentice-Hall

Skill Development Activities (SDA) Suggested

Modelling and Simulation using MATLAB/SIMULINK/MS EXCEL/TABLEAU/MINITAB Tool. Students are expected to validate their models, compare and optimize the model for a *given data set*.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Comprehend the need for Mathematical Modelling, provide insights, validate and apply appropriate modelling techniques to model linear functions	L2
CO2	Apply appropriate modelling techniques to linear and exponential models to data	L3
CO3	Model a polynomial function using appropriate mathematical techniques	L4
CO4	Develop Probabilistic models & derive the diffusion techniques for various applications using numerical methods	L3
CO5	Develop optimizations and statistical models for a given set of data.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO4
5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**3**	**2**	**1**	**1**	**1**
CO2	**2**	**3**	**2**	**1**	**1**	**1**
CO3	**2**	**3**	**2**	**1**	**1**	**1**
CO4	**2**	**3**	**2**	**1**	**1**	**1**
CO5	**2**	**3**	**2**	**1**	**1**	**1**

APPLIED MECHATRONICS			
Course Code	22RAI12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	52 Hrs (40 Hrs Theory+12 Hrs Practical)	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- Students will be able to enumerate and illustrate elements of Mechatronics Systems, its evolution and the underlying multidisciplinary nature of the course.
- For a given problem description, students will be able to select the appropriate sensors, actuators, signal conditioning elements, Microprocessors and control system.
- For a given case study/application, Students will be able to independently analyze the mechatronics system and demonstrate the troubleshooting of the mechatronics system using fault finding techniques
- For the given industrial application, students will be able to design and simulate pneumatic/electro-pneumatic circuits and PLC programs using modern tools/software.
- Students will be able to identify the components of pneumatic/electro-pneumatic, PLC systems and practically execute them on appropriate workstations.

Module-1

Introduction of Mechatronic systems:
Evolution of Mechatronic Systems, Sequential & Concurrent Engineering, Elements of Measurement System. Open and closed loop systems, concepts of feedback, requirement of an ideal control system.
Mathematical Models-Review of Laplace Transforms, Transfer Function Derivation, Models of Mechanical Systems-Linear & Rotary (Spring-Mass-Damper), Mathematical Models of RLC electrical circuits, Analogous Systems

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Matlab Simulation Demonstration of System Response

Module-2

Transducers & Sensors:
Sensors/Transducers, Performance Terminologies, Displacement, Position & Proximity, Velocity & Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors,
Actuation systems:
Electrical systems, Mechanical switches, Relays, solenoids, DC & AC motors, Stepper motors, Series Elastic Actuators and their merits and demerits, Pneumatic Actuators-Symbols, Valves, Cylinders, FRL Unit, Compressors, Hydraulic Actuators-Powerpack, Mathematical models of DC motors and Rotational-Translational Systems

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations, Matlab Simulation Demonstration of System Response

Module-3

Signals & Signal Conditioning:
Introduction to Digital & Analog Signals, Their Merits & Demerits**,** Introduction to signal conditioning. The operational amplifier, Protection, Filtering and Digital Signals, ADC, DAC, Multiplexers, Data acquisition, Pulse-modulation.
Programmable Logic Controllers (PLC)
Introduction to PLC, Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers.

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations, PLC Simulation using Machine Expert Software and Live Demonstrations.

Module-4

Microprocessors
Basic Elements of a Microprocessor: CPU, ALU, Memory, I/O Ports, Bus, Read & Write Cycle. Overview of Architecture of 8085 Microprocessor, Timing & Control Units.

Introduction to Single Board Computers (SBC): Overview of Raspberry Pi Board, NVIDA TEGRA, UDOO, Microprocessors Power Supply, Memory, Ports, GPIOs, setting up the Raspberry Pi (Including Headless Setup), Installing Raspbian, Overview of Raspbian OS, Linux terminal commands for navigation.
Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations, Hands-on Raspberry pi Setup Live Demonstration.
Module-5
Fault Finding Fault Finding Techniques, watchdog Timer, Parity & Error Coding Checks, Common Hardware Faults, Emulation & Simulation **Application Case Studies** Windscreen Wiper Motion, Bathroom Scales, Pick & Place Robot, Car Park Barriers, Digital Camera, Car Engine Management, Bar Code Reader, Hard Disk Drive,
Teaching -Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Practical Component of IPCC

SINO	Experiments
Pneumatics	
1	Marking Machine
2	Clamping Camera Housing
Electro-Pneumatics	
1	Clamping Device
2	Rotary Indexing Table
Programmable Logic Controllers (PLC)	
1	Sequential Motor ON controller
2	Control of Single/Double Acting Cylinder
3	Sequential Control of Multiple Actuators (A+,B+,A-,B-), (A+,B-,B+,A-), (A+,A-,B+, B-)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **30 Marks will be conducted with following weightages**
    a. MSE1-40% Marks
    b. MSE2-40% Marks
    c. MSE3-20% Marks
2. Two assignments each of **10 Marks** or **one Skill Development Activity of 20 marks** to attain the COs and POs

The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) Mechatronics-Electronic Control Systems in Mechanical & Electrical Engineering By W. Bolton, Pearson Publication (2014)

Reference Books

(1) Raspberry Pi Official Documentation

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_me27/preview
- https://www.raspberrypi.com/documentation/

Skill Development Activities (SDA) Suggested:

Mathematical Model Simulation: Mechanical & Electrical System Simulation using SIMULINK (MATLAB)

Demonstration of Raspberry Pi: Interfacing the LED, Buzzer and Input Switches to GPIOs of Raspberry Pi and Programming them using Python.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Elucidate the Mechatronics, Measurement, Control Systems, PLC Controllers and derive the transfer function for the Mechanical & Electrical Systems	L1
CO2	Illustrate & summarize the working principles of Sensors & Actuators and develop mathematical models for Mechanical, Electrical, Electro-Mechanical systems.	L3
CO3	Comprehend the working principles of Signal Conditioning and Programming of PLC and Illustrate and enumerate the microprocessor Architecture and operation of Single Board Computers such as Raspberry Pi.	L2
CO4	Comprehend the Fault-finding Techniques & Enumerate the Various Application Case Studies of Mechatronics Systems	L2
CO5	Develop the Pneumatic/Electro-Pneumatic Circuits for the given application, simulate using FluidSim and practically execute on the FESTO Mobile workstation.	L4
CO6	Develop the PLC Ladder diagrams, simulate using Machine Expert Software and Practically execute the program on the PLC.	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO4

5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			**3**			**1**
CO2			**3**			**1**
CO3			**3**			**1**
CO4	**2**		**3**			**1**
CO5	**2**	**2**	**3**	**3**	**3**	**2**
CO6	**2**	**2**	**3**	**3**	**3**	**2**

ROBOTICS -ANALYSIS & CONTROL			
Course Code	22RAI13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50 Hrs	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

- Identify the various configurations of robots, their anatomy and transformation matrices
- Given an industrial manipulator, students will be able to analyse the kinematics by applying DH Parameters and enumerate the principles of statics associated with them
- Students will be able to analyze the dynamics of manipulators by deriving the equation of motions
- Students will be able to elucidate the issues associated with mobile robots such as its kinematics, localization, obstacle avoidance, sensing and perception
- Students will be able to enumerate the various motion control techniques and application of AI for robots.

Module-1

Serial Linkage Robots: Laws of Robotics, classification of serial manipulator, Anatomy of Robot, Gripper mechanisms, Automation and Robotics, Notation, Position and Orientation of a Rigid Body, Representation of a pure rotation about an axis. Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X-Y-Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates. Robot Design Process.

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration of Transformation Matrices using Videos/RoboAnalyzer

Module-2

Kinematics of serial manipulators: Representation of Links using Denvit- Hartenberg Parameters, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator. Direct kinematics of 2R, manipulator, Inverse kinematics of manipulator. Velocity and **Statics of Manipulators**: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulator, Statics of serial manipulators

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Demonstration of DH parameters using RoboAnalyzer

Module-3

Dynamics of Manipulators:

Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one- and two-degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton- Euler formulation.

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation

Module-4

Mobile Robotics

Classification, Key Issues in Locomotion using Legged and Wheeled Robots, Mobile Robot Kinematics, Mobile Robot Manoeuvrability, Mobile Robot Workspace, Motion Control, Sensors for Mobile Robots. Mobile Robot Localization Techniques, Path Planning & Obstacle Avoidance, Navigation Architectures.

Sensing and Perception

Perception Process, Force and Tactile Sensors, Inertial Sensors, GPS, and Odometry, Sonar Sensing, Multisensor Data Fusion Methods, Multisensor Fusion Architectures, Applications

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Video & Demonstration of Mobile Robots

Module-5

Motion Control

Joint Space Versus Operational Space Control, Independent-Joint Control, PID Control, Tracking Control, Computed-Torque Control, Adaptive Control, Optimal and Robust Control, Digital Implementation, Learning Control. **AI Reasoning Methods for Robotics:** Knowledge Representation and Inference, KR Issues for Robots, Action Planning, Robot Learning

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, PID Simulation using Simulink in Matlab

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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    c. MSE3-20% Marks
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The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) ***Introduction to Robotics, Analysis, Control, Applications*** by Niku S B, Wiley Publication (2011)
(2) ***Handbook of Robotics*** Compiled by Bruno Siciliano, Oussama Khatib Published by Springer (2008)

Reference Books

(1) ***Fundamentals of Robotics, Analysis and Control*** by Schilling R. J, Published by PHI (2010)
(2) Robotics and Control, by Mittal and Nagrath, Tata Mc Grew Hill Publication

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112105249
- http://www.roboanalyzer.com/
- https://www.robotc.net/

Skill Development Activity (SDA)

- Robot Prototype Design using TETRIX STEM Kits
- Analysis of DH Parameters using RoboAnalyzer
- Interface Sensors and Control System for Robots
- Program the robot using Arduino & RobotC
- Solve Open Ended Complex Engineering Problems

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Comprehend Representation of Rigid Bodies in 2D/3D space and apply Mathematical Techniques for transformation of bodies between coordinates	L2
CO2	Apply DH parameters and determine the forward, inverse kinematics and statics of manipulators	L3
CO3	Analyse the dynamics of manipulators using lagrangian equations and Newton- Euler formulation	L4
CO4	Comprehend the fundamentals of Mobile Robots, kinematics, sensing and its perception	L2
CO5	Elucidate the various forms of motion control and AI reasoning methods for Robots	L1

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO4
5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			**3**	**2**		**2**
CO2	**2**		**3**	**2**		**2**
CO3	**2**		**3**	**2**		**2**
CO4	**2**		**3**	**2**		**2**
CO5			**3**	**2**		**2**

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING			
Course Code	22RAI14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the basic theory underlying machine learning.
- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To be able to apply machine learning algorithms to solve problems of moderate complexity.
- To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Module-1

Introduction: Artificial Intelligence (AI) and its importance, AI Problems (tic tac toe problem, water jug problems), Application area of AI. Problem Representations: State space representation, problem-reduction representation, production system, production system characteristics and types of production system.

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation.

Module-2

Heuristic Search Techniques: AI and search process, brute force search, depth-first search, breadth-first search, time and space complexities, heuristics search, hill climbing, best first search, A* algorithm and beam search, AO search, constraint satisfaction.

Search Methods Problem – Solving Agents: Problem Definitions, Formulating Problems, searching for solutions – Measuring Problem – Solving Performance with examples. comparing uniformed search strategies. Informed search strategies – Heuristic information, Hill climbing methods, best – first search, branch – and – bound search, optimal search, and A* and Iterative Deepening A*.

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation.

Module-3

Programming and Logics in Artificial Intelligence LISP and other programming languages – Introduction to LISP, Syntax and numerical function, LISP and PROLOG distinction, input, output and local variables, interaction and recursion, property list and arrays alternative languages, formalized symbolic logics – properties of WERS, non-deductive inference methods.

First Order Predicate Logic (FOPL): Syntax and semantics, conversion to clausal form, inference rules, unification, and the resolution principles

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation.

Module-4

Knowledge Acquisitions: Type of learning, Knowledge Acquisition, Early work in machine learning, learning by induction. Expert System: Introduction to expert system, Phases of expert system, characteristics of expert system and a case study; Introduction of Executive Support System and Decision Support System.

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation.

Module-5

Robotics and Its applications, DDD concept, Intelligent robots, Robot Anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple Problems-Specifications of Robot-Speed of Robot joints and links-Robot Classifications-Architecture of robotic systems-Robot Drive Systems-Hydraulic, Pneumatic and Electric system

Teaching -Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations using MATLAB.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **30 Marks will be conducted with following weightages**
   a. MSE1-40% Marks
   b. MSE2-40% Marks
   c. MSE3-20% Marks
2. Two assignments each of **10 Marks** or **one Skill Development Activity of 20 marks** to attain the COs and POs

The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) Elaine Rich, Kevin Knight, Artificial Intelligence TMH (Any Edition)
(2) S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009

Reference Books

(1) V S Janakiraman, K Sarukesi, P Gopalakrishan, Foundations of Artificial Intelligence and Expert Systems, Macmillan India Ltd.
(2) Dan W. Patterson, Introduction to AI and Expert System, PHI.

Web links and Video Lectures (e-Resources):

https://www.coursera.org/learn/ai-for-everyone
https://www.coursera.org/professional-certificates/applied-artifical-intelligence-ibm-watson-ai

Skill Development Activities Suggested (SDA)

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe human intelligence and AI	L1
CO2	Apply basics of Fuzzy logic and neural networks.	L3
CO3	Apply Knowledge representation and semantic in Knowledge representation	L3
CO4	Develop some familiarity with current research problems and research methods in AI	L4
CO5	Demonstrate and illustrate about functionalities of Robots and Robotics	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1

2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO4
5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**	**3**	**3**	**2**	**3**	**2**
CO2	**3**		**3**		**2**	**3**
CO3		**3**	**2**		**3**	
CO4	**2**	**3**		**3**		**2**
CO5	**3**	**3**	**1**	**1**	**3**	**2**

ROBOT OPERATING SYSTEMS (ROS)			
Course Code	22RAI15	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives

- Elucidate the framework of ROS, its terminologies, Significance and its various distributions
- Enumerate various ROS Commands and apply Rviz & rqt tools for various applications.
- Write ROS programs for various robotic applications
- Utilize the various packages of ROS during application Development
- Illustrate the principles of SLAM & Navigation and apply them on Robot using ROS

Module-1

Introduction –Robot Software Platforms & its need, Objectives of ROS, its Components, ROS ecosystem, History of ROS, ROS Version, Difference between ROS & ROS2. ROS Terminologies: Topic, Action, Parameter, Message Communication Flow. Coordinate Transformation (TF), Client Library, Communication Between Heterogenous Devices, File System, Build System.
Demonstration (Part of SDA): ROS Installation and Configuration

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Live Demo of ROS Installation

Module-2

ROS Commands-Shell Commands, Execution Commands, ROS Information Commands, ROS Catkin Commands, ROS Package Commands. ROS Tools-3D Visualization tool (Rviz), ROS GUI Development Tool (rqt),

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Live Demo of ROS Commands

Module-3

Basic ROS Programming-Creating and Running Publisher and Subscriber Nodes, Creating and Running Service servers and client nodes, Creating and running action server and client node, Using Parameters, Using roslaunch,

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Live Demo of ROS Programming

Module-4

Robot Packages, Sensor Packages, Camera, Laser Distance Sensors, Motor Packages, Public Packages. Embedded Systems-OpenCR, rosserial, Official ROS Hardware Platforms: Turtlebots/Waffle

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Live Demo of ROS Programming using various robot packages

Module-5

SLAM & Navigation-Navigation and Components: Map, Pose, Sensing, Path Calculation and Driving, SLAM Practice: Hardware Constraints, Measured Target Environment, ROS Package for SLAM, SLAM Applications, Various Localization Methods, Navigation Applications, Costmap, AMCL, Dynamic window approach

Teaching-Learning Process: Interactive Discussions using Black Board/Power Point Presentation, Live Demo of SLAM & Navigation application on Robot using ROS

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **30 Marks will be conducted with following weightages**

a. MSE1-40% Marks
b. MSE2-40% Marks
c. MSE3-20% Marks

2. Two assignments each of **10 Marks** or **one Skill Development Activity of 20 marks** to attain the COs and POs

The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbook/ Textbooks

(1) YoonSeok Pyo, HanCheol Cho, RyuWoon Jung, TaeHoon Lim "ROS Robot Programming"- Published by Robotis, 2017

Reference Books

(1) AnisKoubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018
(2) Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press,

Web links and Video Lectures (e-Resources):

https://www.udemy.com/course/ros-essentials/

Skill Development Activities

Mini Project: Implementation of ROS for real life engineering applications

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Elaborate the need for ROS, its framework and distributions	L2
CO2	Apply various ROS Commands and Tools in the ROS Development Environment	L3
CO3	Elucidate the process of basic ROS programming for various applications	L2
CO4	Enumerate Robot Packages and apply them during the Robot Programming	L2
CO5	Comprehend the principles of SLAM and Navigation and its applications	L2

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	PO4
5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5

6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**2**	**3**		**3**	**2**
CO2	**1**	**2**	**3**	**3**	**3**	**2**
CO3	**1**	**2**	**3**	**3**	**3**	**2**
CO4	**1**	**2**	**3**	**3**	**3**	**2**
CO5	**1**	**2**	**3**		**3**	**2**

RESEARCH METHODOLOGY AND IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40 Hrs	Total Marks	100
Credits	03	Exam Hours	03

Course Objectives:

Students will be able

- Illustrate the overview of the research methodology and explain the technique of defining research problem.
- Carry out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- Explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses and Chi-square test.
- Explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Teaching-Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. ■

Teaching-Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Teaching-Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.

Teaching-Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, , Enforcement of Intellectual Property Rights

Teaching-Learning Process: Flipped Classroom-Interactive Discussions using Black Board/Power Point Presentation, Videos and Animations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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    c. MSE3-20% Marks
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The weighted sum of three tests, two assignments/skill Development Activities, will be **evaluated to 50 marks**. **CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5),

Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

Web links and Video Lectures (e-Resources): https://nptel.ac.in/courses/127106227

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	L2
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	L2

Program Outcome of this course

Sl. No.	Description	POs
1.	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2.	An ability to write and present a substantial technical report/document.	PO2
3.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4.	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	PO4
5.	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6.	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**		**3**			**2**
CO2	**3**		**3**			**2**
CO3	**3**		**3**	**2**	**2**	**2**
CO4	**3**	**2**	**3**	**2**		**1**
CO5	**3**		**3**	**2**	**2**	**1**

ROBOT DESIGN & CONTROL LABORATORY			
Course Code	22RAIL17	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	50
Total Hours of Pedagogy	25	Max Marks	100
Credits	02	Exam Hours	03

Course Objectives

- Identify and use the STEM (LEGO NXT) kits and its components for Design and Development of Robots
- Interface NXT Sensors and NXT Actuators to the Robot & Control them using PID
- Write RobotC programming and provide solutions for various open ended engineering challenges

Sl.NO	Experiments
1	LEGO NXT Parts Identifications, GUI, RobotC Programming Overview, Synthesis and Analysis of Mechanisms using LINKAGE & LEGO kit- 4 Bar Linkage Mechanism, Transmission Systems (Gear Drive, Belt Drive, Direct Drive), Interfacing Servo Motors to NXT Brick & PID Control. Application Encoders for Localization and Path Planning, Interfacing Various Contact & Non-Contact Sensors such as Ultrasonic, Light, Touch Sensors etc & Its Control
2	Design of Various Locomotive Design Mechanisms- Wheeled & Legged Robots
3	Design of Generic Mobile Robot Platform
4	Advanced Robot C Programming to solve Open Ended Engineering Problems
5	Labyrinth Challenge-Without Encoder & With Encoder
6	Line Runner Challenge
7	Robo 500 Level 1-4 Challenge
8	Robo Mower Level 1-2 Challenge
9	Auto Attendance Challenge
10	Line Follower Challenge

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 0% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

- MSE-25 Marks
- Record-10 Marks
- Observation-10 Marks
- Viva-05 Marks

The suitable rubrics can be designed to evaluate each student's performance and learning ability.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners (internal & external), examiners are appointed by the Department.

All laboratory experiments are to be included for practical examination.

Suggested Learning Resources:

https://www.robotc.net/
http://www.legoengineering.com/
http://www.legoengineering.com/wp-content/uploads/2013/06/NXT-Constructopedia-Beta-2.1.pdf

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Identify the components of LEGO NXT Brick & its Accessories	L2
CO2	Synthesis and Analyse the Mechanisms using LINKAGE & NXT building elements	L4
CO3	Interface Sensors & Actuators to Controller & Implement Closed loop control system for specific application	L3
CO4	Write RobotC programs with appropriate syntax	L3
CO5	Solve Open Ended Complex Engineering Problems	L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	Students should be able to Design solutions for complex engineering problems using modern tools & techniques with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	PO4
5	Students should be able to Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with professional ethics and norms of the engineering practice.	PO5
6	Students should be able to Demonstrate knowledge and understanding of the engineering and management principles and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**3**	**3**	**3**	**2**
CO2	**3**	**2**	**3**	**3**	**3**	**2**
CO3	**3**	**2**	**3**	**3**	**3**	**2**
CO4	**3**	**2**	**3**	**3**	**3**	**2**
CO5	**3**	**2**	**3**	**3**	**3**	**2**

GUIDELINES FOR ONLINE/MOOC/ABILITY ENHNACEMENT/AUDIT COURSES			
Course Code	22AUD18/22AEC18	CIE Marks	50
Number of contact Hours/Week	As per online course provider's policy	SEE Marks	50
Credits	Nil	Exam Hours	03

COURSE LEARNING OUTCOMES

Students will be able to:

- Understand and recall the concepts in the corresponding subjects.
- Explain concepts using their own words; produce a summary of what they have learned as a test of this ability.
- Apply the concept learnt in solving the assignments questions by searching in websites and submit in Learning management System (LMS).
- Improve communication skills, the participation skills students learn within their online courses translate to many professions, including creating and sharing documents, incorporating audio/video materials into assignments, completing online training sessions, etc
- Provide examples explicating course content, work in groups to find or develop examples from their own lives that further explain core content instead of relying on the instructor.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs. **Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in fields connected to the field of specialisation as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

*** END OF I SEMESTER***