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AI IN ROBOTICS **Course Code : 314333**

Programme Name/s : Automation and Robotics

Programme Code : AO

Semester : Fourth

Course Title : AI IN ROBOTICS

Course Code : 314333

I. RATIONALE

Artificial Intelligence (AI) gives robots a computer vision that enables them to navigate, detect and determine their reactions accordingly. The goals of human-robot interaction are to make daily lives easier, more efficient, and more enjoyable. This course enable students to comprehend principles of AI and apply them in the field of robotics.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following Industry/Employer expected outcome through various teaching learning experiences :

- Simulate automated robotic systems through artificial intelligence concepts.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Determine initial state and goal state for a given problem.
- CO2 - Use relevant AI search strategies for problem solving.
- CO3 - Interpret different types of knowledge and reasoning techniques used in AI.
- CO4 - Apply the learning methods adopted in AI.
- CO5 - Apply the principles of AI in robotics.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314333	AI IN ROBOTICS	AIR	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

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Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the different terminologies of Artificial Intelligence (AI). TLO 1.2 Describe different types of agents. TLO 1.3 Describe initial state and goal state for a given problem. TLO 1.4 Explain the ethics as applicable to AI.	**Unit - I Basics of Artificial Intelligence** 1.1 AI: Definition and characteristics, history, scope, need for AI in Robotics 1.2 Agent and environment: Definition, characteristics and classification of agents, rational agent and intelligent agent, environment and its properties 1.3 State space search: Goal directed agent, State space search notations-Initial state, action or an operator, plan, path cost 1.4 AI Ethics: Transparency, fairness, accountability, privacy, security	Lecture using chalk and board Presentation
2	TLO 2.1 State characteristics of given problem. TLO 2.2 Describe the properties of the search algorithm. TLO 2.3 Explain different uninformed search techniques. TLO 2.4 Explain different informed (heuristic) search techniques. TLO 2.5 Explain local search algorithm.	**Unit - II AI Search Algorithms** 2.1 Search problem: Representation of search problem, illustration of search process 2.2 Search algorithm: Definition, types, properties of search algorithm- completeness, optimality, time complexity and space complexity 2.3 Uninformed search strategies: breadth first search, uniform cost search, depth first search 2.4 Informed (heuristic) search strategies: Greedy best-first search, A* search 2.5 Local search: Local search algorithms and optimization problems; travelling salesman problem, hill climbing search	Lecture using chalk and board Presentation Demonstration

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe different types of knowledge. TLO 3.2 Map between facts and knowledge representation. TLO 3.3 Explain the architecture of knowledge-based agent in Artificial Intelligence (AI). TLO 3.4 Describe forward and backward reasoning. TLO 3.5 Explain different approaches to planning.	**Unit - III Knowledge, Reasoning and Planning** 3.1 Knowledge: Definition and types of knowledge 3.2 Knowledge representation techniques, AI knowledge life cycle 3.3 Knowledge based agent in AI: Introduction, architecture, rules of inference, first order logic, forward chaining and backward chaining 3.4 Reasoning: Definition and its types, forward reasoning and backward reasoning, probabilistic reasoning: need, cause of uncertainty, bayesian reasoning 3.5 Planning: Definition, types of planning, planning graph	Lecture using chalk and board Presentation Demonstration
4	TLO 4.1 Describe different forms of learning. TLO 4.2 Explain the machine learning workflow. TLO 4.3 Predict the potential occurrence of future outcomes. TLO 4.4 Explain probabilistic language processing.	**Unit - IV Learning adopted in AI** 4.1 Forms of learning, knowledge in learning, statistical learning methods, Importance of AI in learning 4.2 Machine learning: Definition, techniques in machine learning – supervised learning, unsupervised learning, reinforcement learning, semi-supervised learning 4.3 Introduction to predictive modeling: definition, stages of predictive modeling – problem definition, hypothesis generation, data extraction/collection, data exploration and transformation, splitting dataset into training set and test set, types of predictive models, algorithms of predictive modelling 4.4 Communication, perceiving and acting, probabilistic language processing and perception	Lecture using chalk and board Presentation Demonstration Flipped Classroom

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe the concept of robotic perception. TLO 5.2 Illustrate the relationship between robotic perception, localization, and mapping. TLO 5.3 Explain the significance of planning uncertain movements in robotics. TLO 5.4 Explain the ethics and risks of artificial intelligence in robotics. TLO 5.5 State the applications of AI in robotics field.	**Unit - V Applications of AI in Robotics** 5.1 AI technology used in robotics, robotic perception, localization, mapping- configuring space 5.2 Planning uncertain movements, dynamics, and control of movement 5.3 Ethics and risks of artificial intelligence in robotics 5.4 Application of AI in automation and robotics-computer vision, AI enabled manipulation and grasping, AI enhanced navigation and motion control, real world perception and natural language processing, future of AI in robotics	Lecture using chalk and board Presentation Demonstration Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Idenitfy the initial state and goal state for 3-pegs problem. LLO 1.2 Write the steps to solve 3-pegs problem as a state space problem.	1	* Identification of initial state and goal state for a given 3-pegs problem	2	CO1
LLO 2.1 Identify the initial state and goal state for the state space problem: Problem is to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal. LLO 2.2 Develop the flowchart for finding initial state and goal state for the state space problem to place 8 queens on a chessboard so that no two queens are in the same row, column or diagonal.	2	Identification of initial state and goal state for a given problem on chessboard	2	CO1
LLO 3.1 Write a program to implement breadth first search algorithm (Uninformed) using python.	3	* Implementation of breadth first search algorithm	2	CO2
LLO 4.1 Write a program to implement depth first search algorithm (Uninformed) using python.	4	Implementation of depth first search algorithm	2	CO2
LLO 5.1 Write a program to implement A* search algorithm for solving the given problem using python.	5	* Implementation of forward chaining algorithm	2	CO2
LLO 6.1 Write a program to implement travelling salesman problem for solving the given problem using python.	6	Implementation of travelling salesman problem	2	CO2
LLO 7.1 Using first order logic write a program to implement forward chaining algorithm using python.	7	* Implementation of forward chaining algorithm	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Using first order logic write a program to implement backward chaining algorithm using python.	8	Implementation of backward chaining algorithm	2	CO3
LLO 9.1 Write a program to implement forward reasoning using python.	9	Implementation of forward reasoning	2	CO3
LLO 10.1 Write a program to implement backward reasoning using python.	10	* Implementation of backward reasoning	2	CO3
LLO 11.1 Write a program to implement Bayesian reasoning using python.	11	Implementation of Bayesian reasoning	2	CO3
LLO 12.1 Write a program to read the data from a given dataset into python.	12	Implementation of data extraction	2	CO4
LLO 13.1 Write a program to split available dataset into training and test set using python.	13	* Develop a program to split dataset	2	CO4
LLO 14.1 Simulate different types of motion commands for robot.	14	* Implementation of motion commands for robot using simulator	2	CO5
LLO 15.1 Simulate different end effector command for given Robot.	15	Implementation of end effector command for a given robot	2	CO5
LLO 16.1 Simulate robot operation using machine vision system.	16	Execution of robotic operations by bridging robot-vision systems	2	CO5
LLO 17.1 Write a program for specific path movement of robot.	17	* Implementation of specific path movement of robot	2	CO5
LLO 18.1 Write a program for painting operation with AI based Robot.	18	Implementation of painting operation with AI based robot	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Case study on various future applications of robotic systems.
- Case study on future AI based technology.
- Case study on robotics system used in the automobile / manufacturing industry.

Student Activity

- Prepare a power point presentation on the topic Future of AI in robotics.
- Prepare a chart on various types of search algorithms.

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computer System (minimum requirement : Processor - 1.5 GHz, RAM - 4GB, Operating System - Windows 7 or above)	All
2	Python Interpreter / IDE	All
3	Python 3.9 or latest version	All
4	Robotics simulation software : RT Toolbox3 / Roboanalyzer or any other simulation software	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Artificial Intelligence	CO1	12	2	4	4	10
2	II	AI Search Algorithms	CO2	16	6	8	8	22
3	III	Knowledge, Reasoning and Planning	CO3	12	2	6	6	14
4	IV	Learning adopted in AI	CO4	14	4	4	6	14
5	V	Applications of AI in Robotics	CO5	6	2	4	4	10
Grand Total				**60**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be considered for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment is of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	-	-	-	-	-			
CO2	3	3	2	2	1	1	1			
CO3	3	2	3	2	1	1	1			
CO4	2	-	3	2	-	-	1			
CO5	3	-	1	3	1	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Russell, S.; Norvig, P.	Artificial Intelligence: A Modern Approach	Publicher: Pearson ISBN : 978-0134610993
2	Poole, David L.; Mackworth, Alan K.	Artificial Intelligence: Foundations of Computational Agents	Publisher: Cambridge University Press ISBN : 978-1107195394
3	Nilsson, Nils J.	The Quest for Artificial Intelligence	Publisher: Cambridge University Press ISBN : 978-0521116398
4	Knight, Kevin; Rich, Elaine; Nair, Shivashankar B.	Artificial Intelligence	Publisher: McGraw Hill Education ISBN : 978-0070087705
5	Jones, M. Tim	Artificial Intelligence: A Systems Approach	Publisher: Jones and Bartlett Learning ISBN : 978-0763773373
6	Govers, Francis X.	Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques	Publisher: Packt Publishing Limited ISBN : 978-1788835442

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Sr.No	Author	Title	Publisher with ISBN Number
7	Deb, S. R.; Deb, Sankha	Robotics Technology and Flexible Automation	Publisher: McGraw Hill Education ISBN : 978-0070077911
8	Chowdhary, K.	Fundamentals of artificial Intelligence	Publisher: Springer India Private Ltd. ISBN : 978-8132239703
9	Murphy, Robin R.	Introduction to AI Robotics	Publisher: The MIT Press ISBN : 978-0262038485
10	Jefferis, David	Artificial Intelligence: Robotics and Machine Evolution	Publisher: Crabtree Publishing Company ISBN : 978-0778700463

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.javatpoint.com/artificial-intelligence-ai	Artificial Intelligence
2	https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial	Artificial Intelligence
3	https://www.tutorialspoint.com/artificial_intelligence/index.htm	Artificial Intelligence
4	https://techvidvan.com/tutorials/robotics-and-artificial-intelligence/	Robotics and AI
5	https://www.bertelkamp.com/media/documents/training/RT_Toolbox3_Details.pdf?_cchid=39fca59addcd41d2401d433a3c68eaf8	Simulation S/W RT Toolbox3
6	https://www.allied-automation.com/rt-toolbox3-robot-simulation/	Simulation S/W RT Toolbox3
7	https://nptel.ac.in/courses/106/105/106105078/	NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IIT Kharagpur
8	https://onlinecourses.nptel.ac.in/noc23_ge40/preview	SWAYAM course- Fundamental of AI) By Prof. Shyamanta M. Hazarika , IIT Guwahati
9	https://www.javatpoint.com/search-algorithms-in-ai	Artificial Intelligence
10	http://www.roboanalyzer.com/uploads/2/5/8/8/2588919/roboanalyzerusermanual.pdf	Roboanalyzer user manual
11	https://cse22-iiith.vlabs.ac.in/exp/self-organizing-maps/	Virtual lab

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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MSBTE Approval Dt. 21/11/2024 **Semester - 4, K Scheme**