



# Birla Institute of Technology & Science, Pilani

Hyderabad Campus

## SECOND SEMESTER 2022-2023 Course Handout Part II

Date: 10-01-2023

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : BITS F327  
Course Title : Artificial Intelligence for Robotics  
Instructor-in-Charge : Dr. Abhishek Sarkar

### Course Description:

#### **BITS F327 Artificial Intelligence for Robotics 2 1 3**

Introduction to AI, Application of AI in Robotics. Introduction to Robot Operating Systems (ROS), Python and programming with application of RaspberryPi and Arduino. Practical Robot Design Process, implementation of pick and place process. Basic robot sensing techniques (Vision and Listening), Beam Models of Range Finders, sensor models. Object Recognition Using Neural Networks and Supervised Learning. Robot learning process, Reinforcement learning and Genetic Algorithms. Basic concepts of speech recognition and natural language. Path planning, SLAM, decision trees, classification techniques, wave front, the A\* (A star) and D\* (D star) algorithms, and node-based planners. Non-deterministic simulation technique and Monte Carlo modeling, the Robot Emotion Engine, the Human Emotion Model.

### Scope and Objective:

The objective of this course is to introduce basic Artificial Intelligence techniques applied in the domain of Robotics. The course is focused on experiential learning, where the programming languages/systems such as Python and ROS are introduced. Hardware such as Raspberry-Pi and Arduino are implemented to develop a real time mobile robot. Gradually, the AI techniques are implemented on the robot to enable pick and place, listen, vision, and pathfinding operations. In this experimental process the theoretical parts of robot vision sensing, localization, SLAM and MCL etc. are introduced. The course will certainly interest students aiming to build-up professional and research career in the field of Robotics.

### Text Book:

(T) Russell, Stuart J., and Peter Norvig, [\*Artificial intelligence: a modern approach\*](#), 3<sup>rd</sup> Edition, Pearson Education India, 2015. [4<sup>th</sup> Edition is also available now]

### Reference Books:

- (R1) Thrun, Sebastian, Wolfram Burgard, and Dieter Fox, [\*Probabilistic robotics\*](#), MIT press, 2006.
- (R2) Martin T. Hagan et al., [\*Neural Network Design\*](#), 2<sup>nd</sup> Edition.
- (R3) S N Sivanandam & S N Deepa, [\*Introduction to Genetic Algorithms\*](#), Springer, 2008.
- (R4) Robin R. Murphy, [\*Introduction to AI robotics\*](#), MIT press, 2000.
- (R5) Richard Szeliski, [\*Computer Vision: Algorithms and Applications\*](#) (Texts in Computer Science), Springer, 2021.



**Course Plan:**

Lecture No.	Learning Objectives	Topics to be covered	Chapter in the Text Book
1-2	Students will become familiar with robotics and artificial intelligence	<b>Introduction to AI, Application of AI in Robotics</b>	[T-1] [R4-1]
		<b>Agent, Motion model</b>	
3-6	Student will learn the mathematics behind the uncertainty computation	<b>Bayes filters</b>	[T-13, 14] [R1-2,3]
		<b>Probability, Gaussian distribution, <math>\alpha</math>-<math>\beta</math>-<math>\gamma</math>, Kalman Filters</b>	
7-10	Student will be able to apply Kalman filter for uncertainty in motion and perception	<b>Basic robot sensing techniques</b>	[T-15] [R1-5,6] [R4-9,10] Classnote
		<b>Dijkstra, A*, D*</b>	
		<b>Beam Models of Range Finders, sensor models.</b>	
11-12	Student will learn to develop an optimal path using genetic algorithms	<b>Terminologies, optimization, Evolutionary computations</b>	[R3-1,2,3,4] Classnote
		<b>Genetic algorithm, advance operations</b>	
13-18	Students will learn SLAM problem	<b>Localization</b>	[R1-7,9,10] [R4-11]
		<b>Mapping</b>	
		<b>Visual SLAM</b>	
		<b>Graph SLAM</b>	
19-22	Student will learn ANN	<b>Introduction, decision trees, classification techniques</b>	[R2-1,2,3,4,7,11]
		<b>Perceptron Learning, Hebbian learning for obstacle avoidance,</b>	
		<b>Backpropagation</b>	
23	Student will learn techniques about Object recognition	<b>Object recognition, Image recognition for learned navigation without a map, Structure and process of solving the problem using AI.</b>	[R5-6, 7, 8, 9]
24-26	Student will learn Reinforcement learning methods for autonomous driving	<b>Markov Chains, MDP, POMDP</b>	[T-21] [R1-14,15]
		<b>Temporal difference, Q-learning</b>	
P1-P2	Familiarizing	<b>Introduction, RaspberryPi coding, sensors</b>	Class-



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	students to Linux, Python & Raspberry Pi	<b>Python – Variables, Loops, Matrix Multiplication/ operation, Functions, Pandas, matplotlib, seaborn</b>	demo, Online resources
P3	Student will learn to code path planning algorithms with Python	<b>Kalman Filter, Dijkstra, A* D*, GA</b>	Class-demo, Online resources



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P4-P6	Students will learn to code for vision sensor	Open CV, Image processing	Class-demo, Online resources
		Feature, pattern recognition	
		Smart car navigation, data collection	
P7	Students will learn to use neural networks and supervised learning techniques	Training and evaluation of neural networks using Keras and TensorFlow, Speech recognition.	Class-demo, Online resources
		Object Recognition Using Neural Networks and Supervised Learning, Basics of image recognition	
P8-P9	Learn to code SLAM problems	Depth estimation, Graph SLAM	Class-demo, Online resources
		Introduction to Deep Learning	
P10-P11	Object detection algorithms will be introduced	CNN, YOLO, etc.	Class-demo, Online resources
P12	Student will learn to code for RL	Dynamic Programming, RL	Class-demo, Online resources

## Evaluation Scheme:

Component	Duration	Weight (%)	Date & Time	Nature of Component*
Assignments	--	15%	Coding based assignments	OB
Quiz	--	10%	To be announced in class (One before mid-sem and one before comprehensive exam)	CB
Project	--	15%	Submission of Presentation and Report (1 week before the start of Comprehensive exams)	OB
Mid-sem Examination	90 min	25%	13/03 9.30 - 11.00AM	CB
Comprehensive - Examination	180 min	35%	08/05 FN	CB

\*Close Book, Open Book

**Chamber Consultation Hour:** Tuesday 4-5 PM & Friday 3-5 PM (Except holidays).

**Notices:** All notices will be put up on CMS/Google classroom.

**Make-up Policy:** Make-up will be given with prior concern and genuine reasons only.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be



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maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**INSTRUCTOR-IN-CHARGE**