Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part II

Date: 15-01-2022

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/system 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*****.** Malaysia; Pearson Education Limited, 2016.

Reference Books:

(R1) Thrun, Sebastian, Wolfram Burgard, and Dieter Fox. ***Probabilistic robotics***. MIT press, 2005.
(R2) Martin T. Hagan et al.; ***Neural Network Design*** 2nd 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.

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	**Introduction to AI, Application of AI in Robotics.**	[T-1] [R4-1]
3-7	Student will learn the mathematics behind the uncertainty computation	**Probability, 4-Bayes filters, $\alpha-\beta-\gamma$ Filter, Kalman Filters.**	[T-13, 14] [R1-2,3]
8-10	Student will be able to apply Kalman filter for uncertainty in motion and perception	**Motion model, Basic robot sensing techniques, Beam Models of Range Finders, sensor models.**	[T-15] [R1-5,6]
11-13	Creating basic knowledge domain in AI techniques applied in mobile robotics	**Path planning, decision trees, classification techniques, wave front, the A* (A star) and D* (D star) algorithms, and node-based planners, Avoiding the Stairs, robot navigation.**	[R4-9,10] Classnote
14-17	Students will learn SLAM problem	**Localization, Mapping and SLAM.**	[R1-7,9,10] [R4-11]
18-19	Student will learn to develop an optimal path using genetic algorithms	**Evolutionary computations, terminologies, advance operations, genetic algorithm optimization.**	[R3-1,2,3,4] Classnote
20-22	Student will learn ANN	**Perceptron Learning, Hebbian learning for obstacle avoidance, Backpropagation.**	[R2-1,2,3,4,7, 11]
23	Student will learn techniques about Object recognition	**Object recognition, Image recognition for learned navigation without a map, Structure and process of solving the problem using AI.**	Classnote
24-26	Student will learn Reinforcement learning methods for autonomous driving	**Markov Chains, MDP, POMDP, Temporal difference, Q-learning.**	[T-21] [R1-14,15]
P1-P3	Familiarizing students to Linux & work with Python	**Install Ubuntu; Python – Introduction, Loops, Functions, etc. Basic, Matrix Multiplication/ operation, Loops function, libraries.**	Class-demo, Online resources
P4-P6	RaspberryPi	**RaspberryPi coding, sensors, actuators.**	Class-demo, Online

			resources
P7	Smart Car Demonstration	**Smart car navigation using LIDAR sensor for the implementation of SLAM problem.**	Class-demo
P8-P10	Enable the student to work on ROS for mobile robot navigation	**Introduction and hands-on with Robot Operating Systems (ROS).**	Class-demo, Online resources
P11-P13	Understand object recognition using neural networks and supervised learning techniques	**Object Recognition Using Neural Networks and Supervised Learning, Basics of image recognition as well as the training and evaluation of neural networks using Keras and Python, Speech recognition.**	Class-demo, Online resources

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Assignments+ Project	--	25%	Submission – 1 week before the start of Comprehensive exams	OB*
Quiz	--	10%	To be announced in class (One before mid-sem and one before compre exam)	OB*
Mid-sem Examination	90 min	25%	15/03 9.00am to10.30am	OB*
Comprehensive-Examination	120 min	40%	17/05 FN	OB*

***Close Book, Open Book**

Chamber Consultation Hour: To be decided based on Timetable.
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 maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE