Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2022-2023

Course Handout Part II

Date: 29-08-2022

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/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,*** 3rd Edition, Pearson Education India, 2015.

Reference Books:

(R1) Thrun, Sebastian, Wolfram Burgard, and Dieter Fox, ***Probabilistic robotics,*** MIT press, 2006.
(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, Agent**	[T-1] [R4-1]
3-6	Student will learn the mathematics behind the uncertainty computation	**Probability, Gaussian distribution,** αβγ **Bayes filters** **Kalman Filters**	[T-13, 14] [R1-2,3]
7-8	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]
9-12	Creating basic knowledge domain in AI techniques applied in mobile robotics	**Path planning, wave front, and node-based planners, Avoiding the Stairs,** **Dijkstra** **A* (A star)** **D* (D star), robot navigation**	[R4-9,10] Classnote
13-14	Student will learn to develop an optimal path using genetic algorithms	**Terminologies, optimization, Evolutionary computations** **Genetic algorithm, advance operations**	[R3-1,2,3,4] Classnote
15-18	Students will learn SLAM problem	**Localization** **Mapping** **Visual SLAM** **Graph SLAM**	[R1-7,9,10] [R4-11]
19-22	Student will learn ANN	**Introduction, decision trees, classification techniques** **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	**Introduction, Install Ubuntu** **Python – Variables, Loops, Matrix Multiplication/ operation.** **Functions, Pandas, matplotlib, seaborn**	Class-demo, Online resources
P4-P5	Student will learn to use RaspberryPi	**RaspberryPi coding, sensors** **Actuators**	Class-demo, Online resources

P6-P8	Students will learn to code for path planning algorithms	**Open CV** **Path planning, GA** **Smart car navigation, data collection**	Class-demo, Online resources
P8-P11	Enable the student to work on ROS for mobile robot navigation	**Introduction and hands-on with Robot Operating Systems (ROS).** **Turtlebot** **Gazebo, SLAM**	Class-demo, Online resources
P12-P13	Understand object recognition using neural networks and supervised learning techniques	**Training and evaluation of neural networks using Keras and TensorFlow, Speech recognition.** **Object Recognition Using Neural Networks and Supervised Learning, Basics of image recognition, CNN, YOLO, etc.**	Class-demo, Online resources

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component*
Assignments	--	10%	4 Assignments (Average of all)	OB
Quiz	--	15%	To be announced in class (One before mid-sem and one before compre exam)	CB
Project		15%	Submission – 1 week before the start of Comprehensive exams	OB
Mid-sem Examination	90 min	25%	31/10 11.00 - 12.30PM	CB
Comprehensive-Examination	180 min	35%	17/12 AN	CB

***Close Book, Open Book**

Chamber Consultation Hour: Tuesday 5-6 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 maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE