

Indian Institute of Technology Kanpur
Proposal for New Courses

Intelligent Autonomous Systems

1. Course No:

2. Course Title: Intelligent Autonomous Systems

3. Per Week Lectures: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Credits (L+T+P+A): 9

4. Duration of Course: Full Semester

5. Proposing Department/IDP: Department of Intelligent Systems

Other Departments/IDPs interested: Aerospace Engineering, Electrical Engineering, Mechanical Engineering, Computer Science and Engineering

6. Proposing Instructor(s): Prof. Salahudden and Prof. Anirban Roy

7. Course Description

A) Objectives

This course introduces intelligent autonomous systems by integrating sensing, planning, intelligent GNC (Guidance, Navigation, and Control), and Artificial Intelligence (AI) techniques for robotics, aerospace systems, autonomous vehicles, UAVs, UGVs, and industrial automation. The course provides a comprehensive understanding of architecture of autonomous systems, covering sensor technologies, decision-making algorithms, intelligent control strategies, machine learning methods, and autonomous mission execution. Emphasis is placed on real world applications through case studies and simulations involving intelligent robotic systems, autonomous vehicles, aerospace platforms, and industrial robotic automation. The course provides knowledge and skills required to design, analyze, and evaluate next generation AI enabled autonomous systems.

B) Contents

S. No	Broad Title	Topics	No. of Lectures
1	Introduction to Autonomous Systems	Evolution of autonomous and intelligent systems; Levels of autonomy; Autonomous agents; Embedded intelligence; Applications in UAVs, UGVs, autonomous vehicles, industrial automation, and aerospace systems.	3
2	Sensors and Environment Modelling	Fundamentals of sensing systems; IMU, GPS/GNSS, LiDAR, Radar, ultrasonic sensors and cameras; Sensor characteristics and calibration;	6

		Sensor error modeling; Environmental modelling; Computer vision fundamentals; Object detection and tracking techniques.	
3	Simultaneous Localization and Mapping	Coordinate frames and transformations; Inertial navigation concepts; Localization techniques; Visual-inertial navigation; Multi sensor fusion methods; quantum navigation with AI.	6
4	Planning and Decision Making	Mission planning concepts; Graph-based path Trajectory generation; Obstacle avoidance; AI based decision making.	5
5	Autonomous Control	Autonomous control approach; Autonomous navigation and guidance; Human-machine interaction; Autonomous tracking systems.	5
6	Artificial Intelligence for Autonomous Systems	Introduction to Artificial Intelligence; Intelligent agents; Supervised learning; Unsupervised learning; Neural networks; Deep learning fundamentals; Reinforcement learning; AI-enabled perception systems; Predictive intelligence; AI-based fault detection and health monitoring.	6
7	Emerging Autonomous Technologies	Cooperative control of multi-agent systems; Swarm intelligence; Digital twins; Space robotics; Autonomous aerospace systems; Future trends in AI enabled autonomy.	5
8	Applications and Case Studies	UAV and UGV simulations for intelligent autonomous mission execution; Intelligent industrial robotics motion control and automation applications.	3

ROS2/Gazebo, MATLAB, OpenCV, PX4, and AI-based mini-projects will be included.

C) Pre-requisites

Basic Programming, Engineering Mathematics, Signals and Systems, Basic Control Systems and Fundamentals of Artificial Intelligence.

D) Short Summary for Course Booklet

A modern interdisciplinary course on intelligent autonomous systems, focusing on autonomy, artificial intelligence, and autonomous decision-making across diverse applications.

8. Recommended References

1. Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, MIT Press.
2. Steven M. LaValle, Planning Algorithms, Cambridge University Press.
3. Peter Corke, Robotics, Vision and Control, Springer.
4. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson.
5. Richard Sutton and Andrew Barto, Reinforcement Learning: An Introduction, MIT Press.
6. Mohinder S. Grewal et al., Global Positioning Systems, Inertial Navigation and Integration, Wiley.

9. Any other Remarks

Evaluation Procedure

- 10% Assignments
- 25% Project Work
- 25% Mid Semester Examination
- 40% End Semester Examination

Dated: 02.06.2025

Proposer: Prof. Salahudden and Prof. Anirban Roy

Dated:

DUGC/DPGC Convener:

The course is approved / not approved

Chairman SUGC/SPGC:

Dated: