10. **RAI-837: Simultaneous Localization and Mapping**

a. Textbook

- Probabilistic Robotics by Sebastian Thrun et al.
- Introduction to Autonomous Mobile Robots by Roland Siegwart and Illah R. Nourbakhsh.
- Handouts and research articles may also be used by the instructor.

b. Objective

- This course focuses on Robot Localization and Mapping in unknown or partially known environments.

c. Course Outcome:

This course will furnish the students with practical knowledge of SLAM algorithms required for mapping and navigation in unknown of partially known environments.

d. Course Outline

- **Introduction to the SLAM**
  - Introduction to mobile robots and SLAM problems
  - Sensor models for SLAM (lidar, camera, odometry)
  - State estimation techniques (Bayesian filters, Kalman filters)
  - Mapping representations (occupancy grids, landmark maps)
  - Performance metrics for SLAM algorithms
- **Fundamental SLAM Algorithms**
  - Extended Kalman Filter (EKF) based SLAM for robots with linear dynamics
  - Unscented Kalman Filter (UKF) for non-linear SLAM problems
  - Rao-Blackwellized Particle Filters (RBPF) for high-dimensional state estimation
- **Advanced SLAM Algorithms**
  - FastSLAM variants (FastSLAM 1.0, 2.0)
  - Tree-based SLAM
  - Graph-based SLAM
  - Optimization-based SLAM
- **Resource-Constrained SLAM**
  - Low-power SLAM algorithms: Prioritizing computational efficiency for power-limited robots.

    - Approximate SLAM techniques: Balancing accuracy and computational cost for real-time applications.
    - Localization with limited resources: Methods for robot localization using minimal sensor data and processing power.
    - Resource-aware SLAM implementation: Considering hardware constraints during algorithm selection and implementation.
- **Visual SLAM**
    - Monocular SLAM
    - Stereo and Multi-camera SLAM
    - ORB-SLAM
    - Large-Scale Direct SLAM
    - SLAM using Catadioptric Sensors
- **SLAM for Complex Robot Platforms**
    - SLAM for robot navigation in social spaces
    - SLAM for UAVs (Unmanned Aerial Vehicles)
    - SLAM for cooperative multi-robot systems
    - SLAM under dynamic environments with moving obstacles