SEMESTER S7

ROBOT NAVIGATION

Course Code	OEBRT723	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCBRT 302	Course Type	THEORY

Course Objectives:

1. Odometry sensors and Colour tracking sensors.
2. Localization-Based Navigation and Programmed Solutions.
3. The navigation function in static deterministic environments

SYLLABUS

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Module No.	Syllabus Description	Contact Hours
1	**Building blocks of navigation:** Definitions - perception, localization, cognition, motion control **Perception:** Sensors for Perception - Schematic representation of the sensing unit, Obstacle Sensor (Bumper), the odometry sensor, Heading sensors - Gyroscopes, IMUs, Distance sensors - ToF, Phase shift, triangulation, ultrasonic rangefinders, Ground based beacons, GPS, Motion field and optical flow, Color tracking sensors, Feature Extraction - Feature Definition, Target Environment, Environment representation	9
2	**Localization**: General schematic for mobile robot localization, Challenge of Localization - Sensor noise and Sensor aliasing, Effector noise, Error model for odometric position estimation Localization-Based Navigation versus Programmed Solutions, Belief Representation, Map Representation - Continuous Representation, Decomposition Strategies, current challenges in map representation, Probabilistic Map-Based Localization - Markov localization, Kalman filter localization, Application to mobile robots: Kalman filter localization -	9

	schematic, Robot position prediction, Observation, Measurement prediction, Matching, Estimation, Landmark- based navigation.	
3	**Motion in Potential Field and Navigation Function-**Problem Statement, configuration space, free configuration space, Gradient Descent Method of Optimization, Gradient Descent without and with Constraints, Minkowski Sum, Potential Field, Navigation Function - in Static Deterministic Environment, in Static Uncertain Environment, Navigation Function and Potential Fields in Dynamic Environment - Estimation, Prediction, Optimization.	**9**
4	**Satellite Navigation** Introduction to Satellite Navigation, Trilateration, Position Calculation - Multipath Signals, GNSS Accuracy Analysis, Dilution of Precision, Coordinate Systems, UTM Projection, Local Cartesian Coordinates, Velocity Calculation, Urban Navigation - Urban Canyon Navigation, Map Matching, Dead Reckoning – Inertial Sensors, Incorporating GNSS Data with INS - Modified Particle Filter, Estimating Velocity by Combining GNSS and INS, A- GPS, DGPS Systems, RTK Navigation, GNSS Threats	**9**

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Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Describe sensors for perception in navigation	**K1**
CO2	Compare various methods for robot localization	**K2**
CO3	Explain the techniques of motion in Potential Field and Navigation Function	**K2**
CO4	Use information from satellites for navigation	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									2
CO2	3	2	3									2
CO3	3	2	3									2
CO4	3	2	3									2
CO5	3	2	3									2

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Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Autonomous Mobile Robots	Roland Siegwart and Illah R. Nourbakhsh	MIT Press	
2	Autonomous Mobile Robots and Multi-Robot Systems - Motion-Planning, Communication, and Swarming	Kagan, Shvalb, Ben-Gal	Wiley	2020
3	Probabilistic Robots	Thrun, Burgard	MIT Press	

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Planning Algorithms	Steven M. LaValle	Cambridge University Press	
2	Robot Motion Planning	Jean- Claude Latombe	Springer Science+Business Media	

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://youtu.be/fnkrocv4Alg
2	https://youtu.be/d4fC2RguJws
3	https://youtu.be/ii-KBKSODek
4	https://youtu.be/rIOdXt7bD3Q
5	https://youtu.be/ieearzWTCZw