MODULE SPECIFICATION

Part 1: Information			
Module Title	Probabilistic Robotics		
Module Code	UFMFNF-15-3	Level	Level 6
For implementation from	2019-20		
UWE Credit Rating	15	ECTS Credit Rating	7.5
Faculty	Faculty of Environment & Technology	Field	Engineering, Design and Mathematics
Department	FET Dept of Engin Design & Mathematics		
Module type:	Standard		
Pre-requisites	None		
Excluded Combinations	None		
Co- requisites	None		
Module Entry requirements	None		

Part 2: Description

Overview: All engineered systems are designed and built within specified tolerances beyond which the costs for physical improvement become prohibitively high. By applying a probabilistic framework tothe use of such systems we can improve their overall performance using computational resources rather than through physical engineering.

This module provides an applied introduction to the mathematics of probability and how it has been used to solve a number of real-world problems in robotics engineering.

Educational Aims: The module will also link the students to the broaderapplications of probability and inference, specifically how it has been incorporated into machine learning and computational neuroscience.

Outline Syllabus: The syllabus includes:

Core teaching:

Probability basics; Random variables and distributions, Conditional probability, Recursive state estimation, Bayes theorem.
Probability applied; Bayesian filters, Hidden Markov Models, Kalman filter(linear, extended, unscented), Histogram and particle filters.

Probabilistic mobile robot localisation and mapping; Markov and Gaussian approaches, Grid and Monte Carlo approaches, Occupancy grid, Simultaneous Localisation and Mapping (SLAM).
Extended applications of probabilistic frameworks; Probabilistic neural models, Inference in machine learning, probabilistic decision making.

Practical teaching:
Robot simulation; Use of contemporary open source robotics simulation engines, Introduction to middleware and robot operating systems.
Probabilistic localisation; Implementation of Bayesian filter algorithms using C and object oriented languages.
Probabilistic mapping; Implementation of occupancy grid mapping in C, interface to simulated sensors and environment.
SLAM; simultaneous localisation and mapping of a simulated mobile robot using a particle filter, re-sampling strategies, noise modelling, loop-closure.

Teaching and Learning Methods: Scheduled learning:

This module will use lectures and computer based laboratory tutorial sessions during which the theories and concepts taught in the lectures will be applied in solving a simulated robotic localisation and mapping problem. The work undertaken in the laboratory sessions will provide the practical skills necessary to undertake a small project which will be the subject of the written report assessed in component B.

Independent learning:

The students have an essential and suggested reading list that include a number of self-directed exercises. They will also be asked to prepare their assignment which will include additional computer based practical work (outside of tutorial time) and a wider literature survey to contextualise their work. Most lectures will also direct the students toward sources of additional interest (online video seminars, special interest web-sites and journals) which will be discussed in subsequent lectures.

Contact Hours:

Activity:
Contact: 36 hours (12x 1hour lectures, 12x 2hour tutorials)
Self-directed learning: 42 hours
Course work: 42 hours
Exam preparation: 30 hours
Total: 150 hours

Part 3: Assessment
The module employs 2 components of summative assessment: Component A: An examination at the end of the semester in controlled conditions (3 hours) covering core concepts learnt in lectures and through self-directed reading. Component B: Submission of a 2500 word written report of applied knowledge developed during laboratory tutorials and directed self-study. The written report has been chosen as a means for assessing the students' ability to apply the theories learnt from the lecture series and self-directed reading. The application of knowledge will be in the form of a computer simulation of robot localisation and mapping, whilst the assessment criteria for the report will be: Level of technical competence Ability to decompose a real problem and to relate to theory Ability to critically analyse different solutions to problems Clarity of presentation, including referencing Level and adequacy of research

First Sit Components	Final Assessment	Element weighting	Description
Report - Component A		50 %	Written report
Examination - Component A	✓	50 %	Examination (3 hours)
Resit Components	**Final Assessment**	**Element weighting**	**Description**
Report - Component A		50 %	Written report
Examination - Component A	✓	50 %	Examination (3 hours)

Part 4: Teaching and Learning Methods

Learning Outcomes

On successful completion of this module students will achieve the following learning outcomes:

Module Learning Outcomes	Reference
Demonstrate an understanding of the core concepts of probabilistic theory and how it has been applied to solve robotic engineering problems	MO1
Describe the broader use of inference algorithms outside of robotic engineering and demonstrate an awareness of the commercial and socio-economic benefits in adopting this approach to problem solving	MO2
Be able to apply a probabilistic framework toengineering problems toward finding optimal solutions to those problems	MO3
Compare and contrast the advantages and limitations of a variety of contemporary implementations of Bayesian filterswhen applied to different robotics problems	MO4
Implement a probabilistic solution to solve the localisation and mapping problem of a simulated mobile robot	MO5
Demonstrate aptitude in self-directed research through finding, analysing and assimilating current technical literature and other information sources	MO6

Contact Hours

Independent Study Hours:	
Independent study/self-guided study	114
Total Independent Study Hours:	114
Scheduled Learning and Teaching Hours:	
Face-to-face learning	36
Total Scheduled Learning and Teaching Hours:	36
Hours to be allocated	150
Allocated Hours	150

Reading List	*The reading list for this module can be accessed via the following link:* https://uwe.rl.talis.com/modules/ufmfnf-15-3.html

Part 5: Contributes Towards
This module contributes towards the following programmes of study: