



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024**

- COURSE NAME : MOBILE ROBOTICS
- COURSE CODE : BEJ44703
- PROGRAMME CODE : BEJ
- EXAMINATION DATE : JULY 2024
- DURATION : 3 HOURS
- INSTRUCTIONS :
1. ANSWER ALL QUESTIONS
 2. THIS FINAL EXAMINATION IS CONDUCTED VIA
 - Open book
 - Closed book
 3. STUDENTS ARE PROHIBITED TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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PART A

Q1 Consider the following Bayesian filter equation.

$$Bel(x_t) = \eta p(z_t|x_t) \int p(x_t|x_{t-1}, u_t) Bel(x_{t-1}) dx_{t-1},$$

- (a) Evaluate the Bayesian filter equation above and Derive a Kalman Filter equation for a correction function $p(z_t|x_t)$ and a prediction function $\int p(x_t|x_{t-1}, u_t) Bel(x_{t-1}) dx_{t-1}$,
(10 marks)
- (b) Describe the Kalman Filter correction and the prediction function for a mobile robot localization.
(5 marks)
- (c) Based on the Kalman Filter equations, write a python programming for mobile robot localization.
(10 marks)

Q2 Consider the following Particle Filter based-on the Bayesian filter equation

$$Bel(x_t) = \eta p(z_t|x_t) \int p(x_t|x_{t-1}, u_t) Bel(x_{t-1}) dx_{t-1},$$

- (a) Point out the process of particle filter algorithm from the Bayesian filter equation.
(10 marks)
- (b) Describe the Particle -filter algorithm for localization.
(6 marks)
- (c) Based on the Particle filter algorithm, write a python programming for mobile robot localization
(9 marks)

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Q3 (a) Define the grid Map used for SLAM.

(5 marks)

(b) A Grid Map equation is given by

$$p(m|x_{1:t}, z_{1:t})$$

Derive a grid map algorithm (include the probability, binary bayes filter) from the equation above.

(10 marks)

(c) Given by the observation sensor data $Z_{1:t}$ and localization data $x_{1:t}$ calculate the belief $Bel(m^{i,j})$ of each 4 grid map in Table Q3(c).

Table Q3(c)

Hits :4 Miss:6	Hits :6 Miss:4
Hits :2 Miss:8	Hits :7 Miss:3

(10 marks)

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Q4 (a) Define A* path-planning.

(2 marks)

(b) Discuss the process of the Dynamic Window Approaches for the path-planning.

(3 marks)

(c) Differentiate the **FIVE (5)** differences between A* and the Dynamic Window Approaches for the path-planning.

(10 marks)

(d) A typical problem of the A* is given by **Figure Q4(d)**. Analyze the reason behind this problems and provide the solutions.

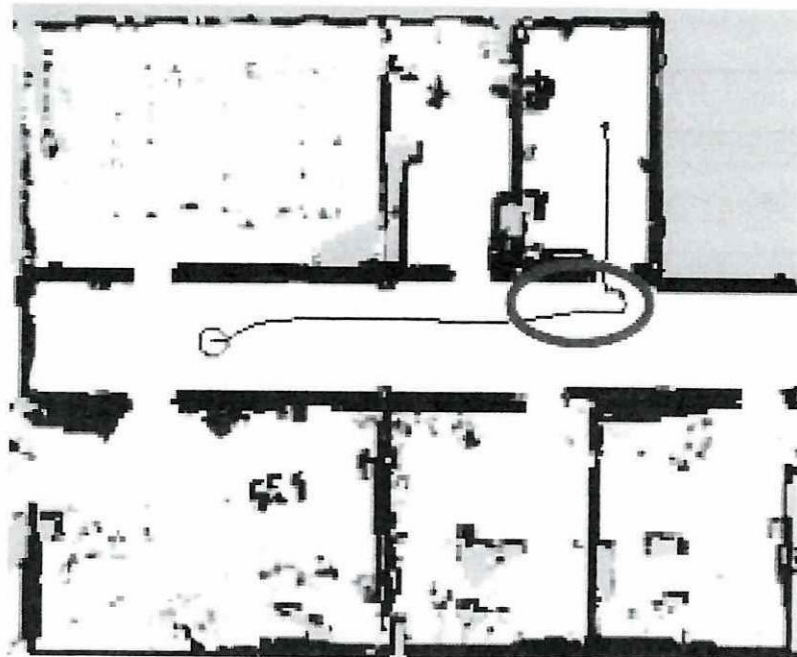


Figure Q4(d)

(10 marks)

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- END OF QUESTIONS -