

THE HONG KONG POLYTECHNIC UNIVERSITY
DEPARTMENT OF ELECTRICAL ENGINEERING

Subject Code : EE520
Subject Title : Intelligent Motion Systems
Session : Semester 2, 2022/23 **Venue** : FSCH
Date : 6 May 2023 **Time** : 19:00 – 22:00
Time Allowed : 3 Hours **Subject Examiner(s)** : NC Cheung

This question paper has a total of 3 pages (attachments included).

Instructions to Candidates: Attempt ALL questions. All questions carry equal marks.

Physical Constants: Nil

Other Attachments: Nil

Available from Invigilator: Nil

DO NOT TURN OVER THE PAGE UNTIL YOU ARE TOLD TO DO SO.

Question 1

- (a) What are the differences between point-to-point motion and trajectory tracking motion? Give your answer in terms of (i) operational differences, and (ii) control hardware structure differences. (6 marks)
- (b) Explain the term “Mixed Mode Motion Control”. (4 marks)
- (c) Fig. Q1 shows the robot designed to pick and place delicate objects, such as eggs, from an egg casket to a bowl. This pick and place operation needs to be executed as quickly as possible. Use a flow chart to describe one complete pick and place motion cycle. Assume that the robot has a gripper axis, an up/down Z axis, and a 2-dimensional X-Y axes. (10 marks)

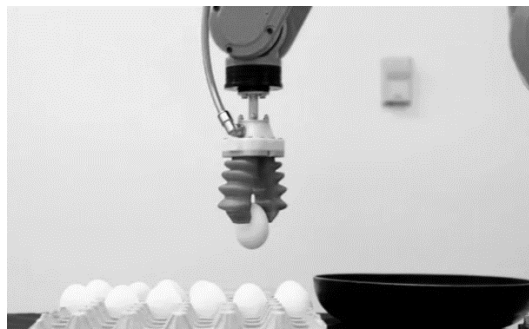


Fig. Q1

Question 2

- (a) Explain how you could obtain the position and speed of the motion, by using the phase A, phase B signals, and the index signals from the linear encoder, through quadrature decoding. (12 marks)
- (b) By examining the structures of the motors, explain why a dc brush-type motor is not suitable for high-speed high-precision motion control, but a permanent magnet brushless dc motor is more suitable. (8 marks)

Question 3

- (a) Explain how the mechanical resonant problem of a stepping motor affects its low-speed motion performance. Also, explain why this poor low-speed motion performance would affect the low-speed drawing capability of 2 dimensional plotters based on stepper motors. (8 marks)
- (b) By examining the structure of a linear slide based on a direct drive linear motor, and a linear slide based on a rotary motor with mechanical translators, explain why the former type has a much superior performance than the latter type? (12 marks)

Question 4

- (a) Comparing with direct wiring, explain what are the advantages of using SERCOS in multi-axes feedback motion control system? (10 marks)
- (b) Explain the following terms:
- (i) SISO systems
 - (ii) Identification
 - (iii) Modelling
 - (iv) Control Strategy Development
 - (v) Simulation
 - (vi) Implementation
 - (vii) Performance Index
 - (viii) System Robustness
 - (ix) External Disturbance
 - (x) MIMO systems (10 marks)

Question 5

- (a) Describe a force transducer that can be used to sense the X, Y and Z forces and their turning torques. Explain (i) the mechanical structure, (ii) how the measure signals are obtained, and (iii) how these signals can be decoded into the 6 axes measurements. (10 marks)
- (b) Explain how you could measure the conductive interference of an equipment set. What is the equipment setup? What is the normal frequency range of measurement? What are the precautions needed for this type of measurement? (10 marks)

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