THE HONG KONG POLYTECHNIC UNIVERSITY

DEPARTMENT OF ELECTRICAL ENGINEERING

Subject Code	:	EE520/ EE520A		
Subject Title	:	Intelligent Motion Systems		
Session	:	Semester 2, 2021/22	**Venue** :	Online Examination
Date	:	7 May 2022	**Time** :	19:00 – 22:00
Time Allowed	:	3 Hours	**Subject Examiner(s)** :	Dr N.C. Cheung

This question paper has a total of __3__ pages (attachments included).

Instructions to Candidates: Attempt ALL Questions

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) For each of the motion control modes below, draw the functional block diagram, describe its operational characteristics, and suggest an application for this mode of motion.   (9 marks)

    i.   Force Control
    ii.   Velocity Control
    iii. Trajectory Control

(b) A high-speed elevator of a tall commercial building (> 50 storeys) needs to take its passengers from one floor level to the next in the shortest possible time, and has to stop at the exact floor height level (within 1-cm tolerance).   (11 marks)

    i.   Describe the different types of motion modes that this elevator has to go through, for one cycle of motion, including the conditions for switching between different motion modes.
    ii.   Any other considerations that the motion control has to consider, in order to produce the best performance?

Question 2

(a) Fig. Q2 shows the voltage output and the connections of the rotor and the stator of a sensor. Describe the construction of this type of sensor, and explain its operating principle.   (8 marks)

(b) By using the voltage outputs from the graph shown in Fig. Q2, describe how you could design an interpolation circuit which can increase the output resolution by 16 times (i.e. one cycle of sinusoidal waveform can produce 16 up/down count pulses of position information.).   (12 marks)
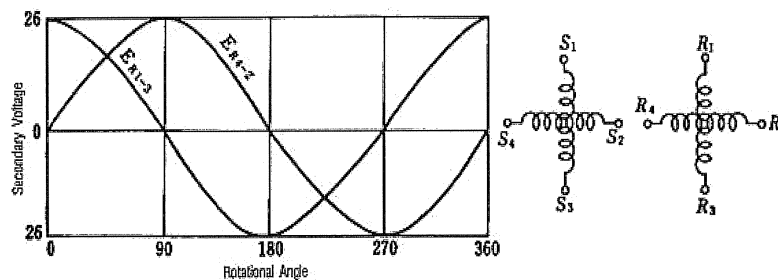

Fig. Q2

Question 3

(a) A linear slide is driven by a stepping motor in open loop mode. The slide has to execute point-to-point motion within the shortest possible time. Explain how to solve this difficulty by using the following measures: (10 marks)

    i. Start and stop stepping speed profiles.
    ii. Increase the rise and fall times of driving pulses.

(b) Suggest two ways in which a PC motherboard could be converted into a real time motion control system. Compare the advantages and disadvantages between the two suggestions.   (10 marks)

Question 4

(a) Explain the principle of "gain scheduling" in a PID control system, and show how it can improve the performance of a pick-and-place machine with large load variations.   (6 marks)

(b) Explain why the derivative control block is not necessary in a 3-stage cascade type PI servo control structure.   (6 marks)

(c) Use a flowchart to illustrate the search algorithm of an autotuning system for feedback type motion control. Explain why the optimum point cannot be reached in some cases.   (8 marks)

Question 5

Explain how you could use feedforward compensation to improve the performance of a linear actuator under feedback control, when it is under the conditions stated in (a) to (d) below. For each of the case below, draw the mechanical structure and its control block diagram, and briefly explain its operating principle.

(a) Centrifugal force compensation   (5 marks)

(b) Gravitation force variation compensation   (5 marks)

(c) Spring loaded compensation   (5 marks)

(d) Acceleration and deceleration compensation   (5 marks)

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