

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4146 Industrial Electronics
Session : Semester B 2004/05
Time allowed : Two hours

This paper has FIVE pages (including this cover page).

1. This paper consists of **4** questions.
2. Each question carries equal marks.
3. Answer any **3** questions.
4. Start each question on a new page.

Q1.

- A.
- Steepest descent algorithm is used for updating the weights, $W(k)$ at the k^{th} iteration, of a neural network. State and describe the learning rule in terms of the weight vector, $W(k)$, and the learning rate, η . Also, explain the rationale behind the selection of the learning rate, η . (10 marks)
 - Use the steepest descent method to search for the minimum of $f(x_1, x_2) = 25x_1^2 + x_2^2$ with the initials set at $X(0) = [1 \ 3]^T$, and the step size set to 0.5. State the steps and calculate $X(1)$. (10 marks)
 - Rewrite the learning rule defined in part i. by using the LMS algorithm. (4 marks)
 - Briefly compare 2 main advantages and disadvantages of the gradient descent algorithm and the LMS algorithm. (4 marks)
 - The LMS algorithm is used to implement the dual-input, single weight adaptive noise canceller shown in Figure Q1. Set up the equations that define the operation of this algorithm. (5 marks)

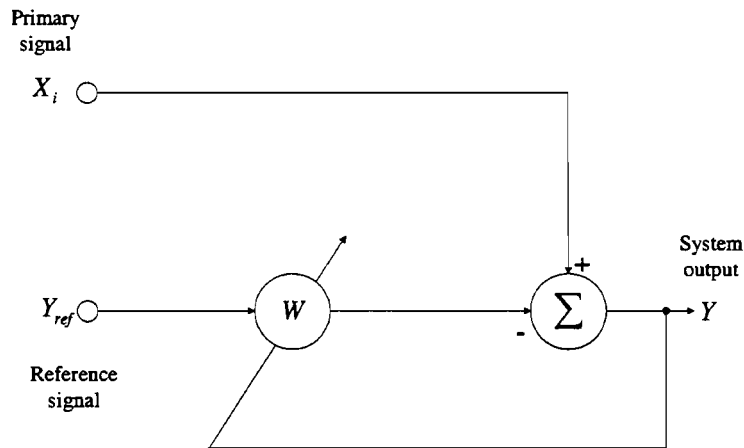


Figure Q1

Q2.

- i. Construct the circuit diagram of a flyback converter. (3 marks)
- ii. Explain the operation of a discontinuous mode flyback converter by constructing the voltage and current waveforms. (12 marks)
- iii. Show and explain how the reverse voltage across the transistor at continuous mode operation is different from that at discontinuous mode. (5 marks)
- iv. Explain why this type of converter is preferable to operate at discontinuous mode. (3 marks)
- v. Given that the change of magnetic flux in the charging phase can be represented by the relationship:

$$\Delta\phi_c = \frac{V_{in}DT}{N_p},$$

where $\Delta\phi_c$ is the change of magnetic flux in the charging phase, V_{in} is the input voltage, DT is the end of the on-time, T is the switching period, and N_p is the number of primary turns. Show that D_{max} can be expressed as

$$D_{max} = \frac{1}{1 + \frac{V_{in}(\min)}{V_{fb}}},$$

where $V_{in}(\min)$ is the minimum input voltage, and V_{fb} is the feedback voltage. (6 marks)

Hence, comment on the major implication of D_{max} in terms of practical design consideration. (4 marks)

Q3.

A.

- i. List 3 points to compare the advantages and disadvantages of an A.C and an D.C drive system. (3 marks)
- ii. State the major differences of the railway traction systems between the Hong Kong MTR and the KCRC. (3 marks)
- iii. Sketch a fully-controlled single-phase bridge rectifier with a free diode connecting across the load. The circuit operates with a firing angle of 30° . Assuming it is not a level output current, sketch the load voltage, load current, thyristor currents, and thyristor voltage waveforms of this circuit.

(13 marks)

- iv. Explain the effect of the freewheeling diode. (4 marks)

B. Figure Q3 is a switching type regulator.

- i. Use two separate circuit diagrams to explain its function and its operating mechanism when it is in the “switch on” and “switch off” modes, respectively. (10 marks)

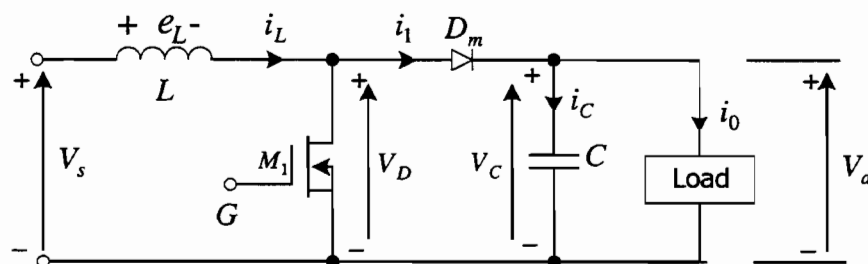


Figure Q3

Q4.

A.

- i. Use an equation to explain how the weights of a Self-Organizing-Map are updated? (3 marks)
- ii. Initialization, Competition, and Neighborhood function are three important process in a Self-Organizing-Map. Briefly describe how each of these components is implemented. (6 marks)
- iii. Design a neighbourhood function for working together with the weights updating. State the function and describe the rationale behind your design. (6 marks)
- iv. A SOM has 4 neurons in the competitive layer and 2 nodes in the input layer. It is initialized with the following weight matrix:

$$w = \begin{bmatrix} 1.0 & 0.0 \\ 0.5 & 0.5 \\ 0.0 & 0.4 \\ 1.2 & 0.0 \end{bmatrix}.$$

Perform one cycle of iterations of the SOM algorithm to learn the following patterns sequentially:

$X_1=(1.7 \ 1.1)$, $X_2=(0.4 \ 0.8)$, and $X_3=(0.8 \ 0.1)$.

The learning parameter is 0.8 for the winner neuron, and 0.1 for other neurons. (8 marks)

- B. Figure Q4 shows a neuron with a unit step activation function, and a bias of 0.5. It has two binary inputs. Find the space of the possible values of weights (α , β) if the neuron is
- (i) OFF for input (1.0, 1.0)
 - (ii) OFF for input (0.5, -1.0)
 - (iii) ON for input (0.5, 0.5).
- (10 marks)

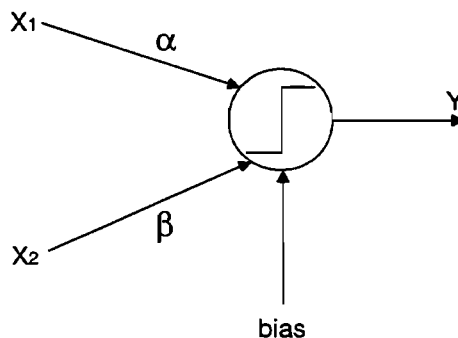


Fig. Q4

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