

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4146 Industrial Electronics
Session : Semester B 2003/04
Time allowed : Two hours

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

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

Q1.

Figure Q1a is a circuit diagram of Flyback converter.

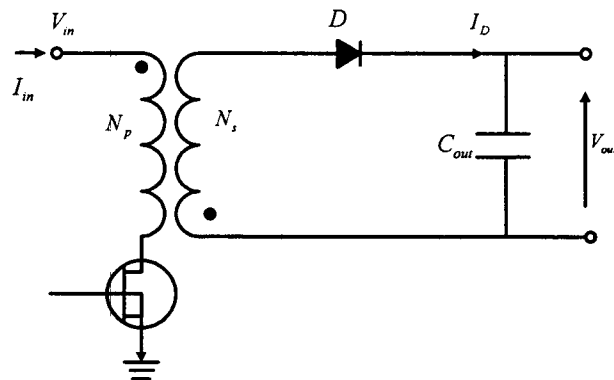


Figure Q1a

- i. When the transistor is off, show and explain the reverse voltage across the transistor by constructing the corresponding waveforms of input current, reverse voltage across the transistor, diode current, and reverse voltage across the diode D for discontinuous mode operation. (8 marks)
- ii. Show and explain how the reverse voltage across the transistor is different at continuous mode operation. (5 marks)
- iii. It is desirable to reduce the magnitude of the reverse voltage across the transistor. But there is one major design constraint that limits the reverse voltage. Briefly describe such a constraint. (4 marks)
- iv. Explain why this type of converter is more preferable to operate at a discontinuous mode. (4 marks)
- v. Explain why this type of converter cannot operate at high power rating. (4 marks)
- vi. Suggest another type of converter which can operate at high power rating. Hence describe its distinctive features. (8 marks)

Q2.

A.

- i. Figure Q2a is a switching regulator. 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. (8 marks)

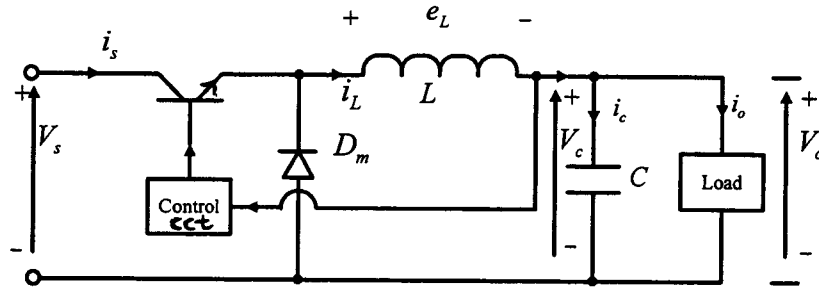


Figure Q2a

- ii. Construct the waveforms of the switching pulses and the corresponding i_L , i_c , reverse voltage across the diode, and the voltage across the load. (8 marks)

B.

- i. Figure Q2b is a typical half-controlled single-phase bridge. Construct an equivalent circuit diagram and explain how it is used to model the circuit when the two thyristors are starting to switch over. (5 marks)

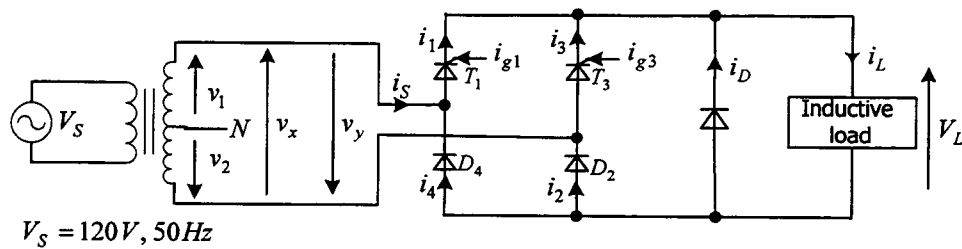


Figure Q2b

- ii. State the two main advantages of using a half-controlled converter over a full-controlled converter. (4 marks)
- iii. Make use of the equivalent circuit to show that the overlap angle, γ , of the device can be expressed as

$$\cos \gamma = 1 - \frac{i_L \omega L}{V_{\max} \sqrt{2}}, \text{ where } i_L \text{ is the load current, } \omega \text{ is the angular frequency of the supply, and } L \text{ is the inductance. (8 marks)}$$

Q3.

- A. i. In a neural network learning rule, the updating rule is given as

$$W(k+1) = W(k) - \eta \nabla J(k),$$

where $W(k+1)$ denotes the weightings at the $k+1^{th}$ iteration, $\nabla J(k)$ denotes the gradient of the performance surface at the k^{th} iteration, and η is the learning rate. Specify a stopping criterion and list the procedures of the above learning rule. (6 marks)

- ii. Rewrite the above learning rule by using LMS algorithm. (3 marks)
- iii. Briefly compare the advantages and disadvantages of gradient descent algorithm and LMS algorithm. (6 marks)
- iv. In Figure Q3a, it shows a linear predictor with its input vector made up of the samples $x(n-1)$, $x(n-2)$, ..., $x(n-p)$, where p is the predictor order. Use the LMS algorithm to make a prediction, $\hat{x}$, of the input sample $x(n)$. Set up the recursions that may be used to determine the tap weightings of the predictor. (10 marks)

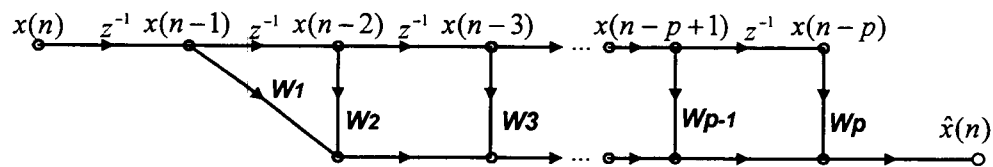


Figure Q3a

- v. In Figure Q3b, it shows a two-layer feedforward network with 2 hidden neurons and 1 output neuron used to solve the AND problem. Assume there is no bias and the activation functions of all neurons are 1. The weightings connecting the output neuron to the two hidden neurons are x_{31} , x_{32} . It is given that the values of x_{31} , x_{32} are 2. List the 4 equations at the output neuron in terms of the network weightings and inputs. Hence, demonstrate how the other weightings can be briefly estimated. List the assumptions used in estimating the weightings. (8 marks)

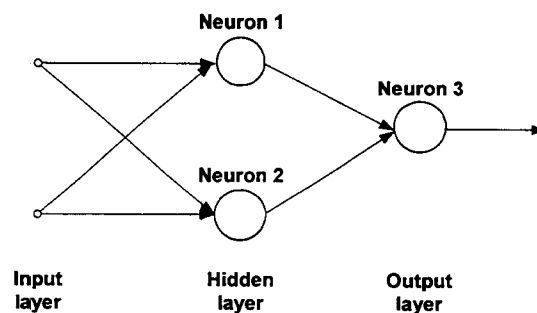


Figure Q3b

Q4.

- i. Figure Q4a shows a simple connection between an output neuron and hidden neurons of a feedforward neural network, where W_{jk} is the weight between the output neuron Out_j and hidden neuron h_k . Use gradient descent type updating rule, $\Delta W_{jk} = -\eta \frac{\partial E}{\partial W_{jk}}$, to show that the weights are optimized by the following expression.

$$\Delta W_{jk} = \eta O_j (t_j - O_j) f'_j \left(\sum_k W_{jk} O_k \right),$$

where η is the learning rate, $E = t_j - O_j$ is the error at the output neuron, t_j and O_j are the target value and the output value of the output neuron respectively. (10 marks)

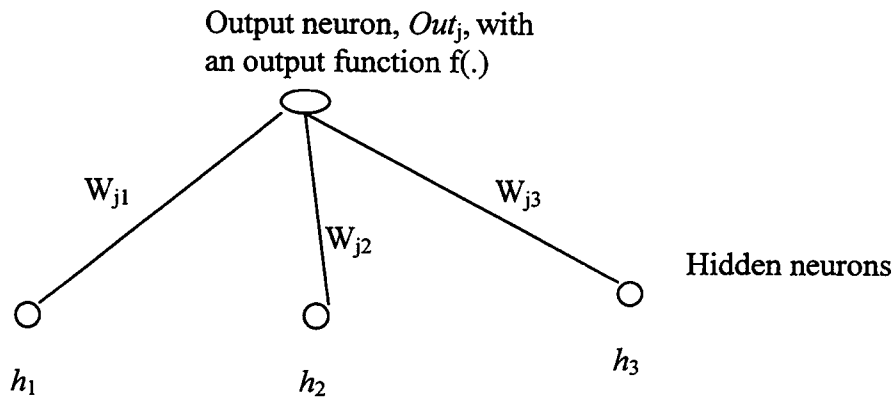


Figure Q4a

- ii. Hence describe an essential requirement of the output function $f(\cdot)$. (3 marks)
- iii. Name two major factors that affect the convergence of the training process. (3 marks)
- iv. Name two approaches that may be used together with the conventional gradient descent algorithm to enhance the training performance. (3 marks)

- v. Figure Q4b shows a recurrent type connection in which the neuron sums the input and the feedback signals and input into an output function. Assume $f(x)=1$, derive an expression of $y(k)$ in terms of w_f, w_1 , and $x(k)$.

(10 marks)

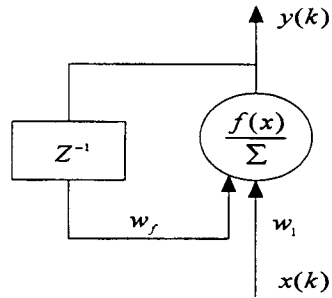


Figure Q4b.

- vi. Hence state the stability condition for $y(k)$.

(4 marks)

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