31 Years Solved Papers

GATE 2021

Computer Science & Information Technology

- Fully solved with explanations
- Topicwise presentation
- Analysis of previous papers
- Thoroughly revised & updated

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GATE - 2021 : Computer Science & IT Topicwise Previous Solved Papers (1990-2020)

First Edition	:	2007
Second Edition	:	2008
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Fourteenth Edition	**:**	**2020**

Preface

B. Singh (Ex. IES)

Over the period of time the GATE examination has become more challenging due to increasing number of candidates. Though every candidate has ability to succeed but competitive environment, in-depth knowledge, quality guidance and good source of study is required to achieve high level goals.

The new edition of **GATE 2021 Solved Papers : Computer Science & Information Technology** has been fully revised, updated and edited. The whole book has been divided into topicwise sections.

At the beginning of each subject, analysis of previous papers are given to improve the understanding of subject.

I have true desire to serve student community by way of providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in GATE examination. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

Contents

Unit . X

Computer Networks

Contents

UNIT X

Computer Networks

Syllabus : ISO/OSI stack, LAN technologies (Ethernet, Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and sockets, IP (v4), Application layer protocols (icmps, dns, smtp, pop, ftp, http); Basic concepts of hubs, switches, gateways and routers.

Network Security: Basic concepts of public key and private key cryptography, digital signature, firewalls.

Analysis of Previous GATE Papers

Exam Year	1 Mark Ques.	2 Marks Ques.	Total Marks
2003	2	3	**8**
2004	3	4	**11**
2005	5	2	**15**
2006	1	5	**11**
2007	2	6	**14**
2008	1	4	**9**
2009	–	5	**10**
2010	2	3	**8**
2011	2	2	**6**
2012	3	3	**9**
2013	3	2	**7**
2014 Set-1	2	3	**8**
2014 Set-2	3	2	**7**
2014 Set-3	3	3	**9**
2015 Set-1	4	2	**8**
2015 Set-2	2	3	**8**
2015 Set-3	2	3	**8**
2016 Set-1	2	4	**10**
2016 Set-2	3	4	**11**
2017 Set-1	2	3	**8**
2017 Set-2	3	2	**7**
2018	3	2	**7**
2019	2	4	**10**
2020	2	2	**6**

1 ISO/OSI Stack and SWP

1.1 Host A is sending data to host B over a full duplex link. A and B are using the sliding window protocol for flow control. The send and receive window sizes are 5 packets each. Data packets (sent only from A to B) are all 1000 bytes long and the transmission time for such a packet is 50 μs. Acknowledgment packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 μs. What is the maximum achievable throughput in this communication?

(a) 7.69×10^6 bps (b) 11.11×10^6 bps
(c) 12.33×10^6 bps (d) 15.00×10^6 bps

[2003 : 2 Marks]

1.2 Choose the best matching between **List-I** and **List-II**.

List-I
P. Data link layer
Q. Network layer
R. Transport layer

List-II
1. Ensures reliable transport of data over a physical point-to-point link
2. Encodes / decodes data for physical transmission
3. Allow end-to-end communication between two processes
4. Routes data from one network node to the next

	P	Q	R
(a)	1	4	3
(b)	2	4	1
(c)	2	3	1
(d)	1	3	2

[2004 : 1 Mark]

1.3 How many 8-bit characters can be transmitted per second over a 9600 baud serial communication link using asynchronous mode of transmission with one start bit, eight data bits, and one parity bit and two stop bits?

(a) 600 (b) 800
(c) 876 (d) 1200

[2004 : 1 Mark]

1.4 A serial transmission T1 uses 8 information bits, 2 start bits, 1 stop bit and 1 parity bit for each character. A synchronous transmission T2 uses 3 eight-bit sync characters followed by 30 eight-bit information characters. If the bit rate is 1200 bits/second in both cases, what are the transfer rates of T1 and T2?

(a) 100 characters/sec, 153 characters/sec
(b) 80 characters/sec, 136 characters/sec
(c) 100 characters/sec, 136 characters/sec
(d) 80 characters/sec, 153 characters/sec

[2004 : 2 Marks]

1.5 In a data link protocol, the frame delimiter flag is given by 0111. Assuming that bit stuffing is employed, the transmitter sends the data sequence 01110110 as

(a) 01101011 (b) 011010110
(c) 011101100 (d) 0110101100

[2004 : 2 Marks]

1.6 In a sliding window ARQ scheme, the transmitter's window size is N and the receiver's window size is M. The minimum number of distinct sequence numbers required to ensure correct operation of the ARQ scheme is

(a) min (M, N) (b) max (M, N)
(c) M + N (d) MN

[2004 : 2 Marks]

1.7 A 20 Kbps satellite link has a propagation delay of 400 ms. The transmitter employs the "go back n ARQ" scheme with n set to 10. Assuming that each frame is 100 bytes long, what is the maximum data rate possible?

(a) 5 Kbps (b) 10 Kbps
(c) 15 Kbps (d) 20 Kbps

[2004 : 2 Marks]

1.8 Consider a parity check code with three data bits and four parity check bits. Three of the code words are 0101011, 1001101 and 1110001.

Which of the following are also code words?

I. 0010111 II. 0110110
III. 1011010 IV. 0111010

(a) I and III (b) I, II and III
(c) II and IV (d) I, II, III and IV

[2004 : 2 Marks]

1.9 The maximum window size for data transmission using the selective reject protocol with n-bit frame sequence numbers is

(a) 2^n (b) 2^{n-1}
(c) $2^n - 1$ (d) 2^{n-2}

[2005 : 1 Mark]

1.10 Consider the following message M = 1010001101. The cyclic redundancy check (CRC) for this message using the divisor polynomial $x^5 + x^4 + x^2 + 1$ is :

(a) 01110 (b) 01011
(c) 10101 (d) 10110

[2005 : 2 Marks]

1.11 A channel has a bit rate of 4 kbps and one-way propagation delay of 20 ms. The channel uses stop and wait protocol. The transmission time of the acknowledgement frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be

(a) 80 bytes (b) 80 bits
(c) 160 bytes (d) 160 bits

[2005 : 2 Marks]

1.12 In the 4B/5B encoding scheme, every 4 bits of data are encoded in a 5-bit codeword. It is required that the codewords have at most 1 leading and at most 1 trailing zero. How many such codewords are possible?

(a) 14 (b) 16
(c) 18 (d) 20

[2006 : 2 Marks]

1.13 On a wireless link, the probability of packet error is 0.2. A stop-and-wait protocol is used to transfer data across the link. The channel condition is assumed to be independent from transmission to transmission. What is the average number of transmission attempts required to transfer 100 packets?

(a) 100 (b) 125
(c) 150 (d) 200

[2006 : 2 Marks]

1.14 Station A uses 32 byte packets to transmit messages to Station B using a sliding window protocol. The round trip delay between A and B is 80 milliseconds and the bottleneck bandwidth on the path between A and B is 128 kbps. What is the optimal window size that A should use?

(a) 20 (b) 40
(c) 160 (d) 320

[2006 : 2 Marks]

1.15 Station A needs to send a message consisting of 9 packets to Station B using a siding window (window size 3) and go-back-n error control strategy. All packets are ready and immediately available for transmission. If every 5^{th} packet that A transmits gets lost (but no acks from B ever get lost), then what is the number of packets that A will transmit for sending the message to B?

(a) 12 (b) 14
(c) 16 (d) 18

[2006 : 2 Marks]

1.16 The message 11001001 is to be transmitted using the CRC polynomial $x^3 + 1$ to protect it from errors. The message that should be transmitted is:

(a) 11001001000 (b) 11001001011
(c) 11001010 (d) 110010010011

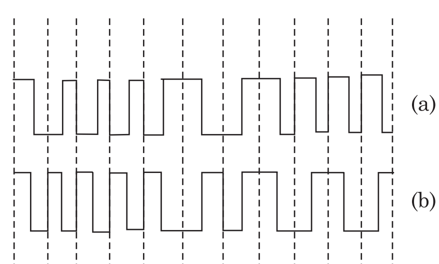
[2007 : 2 Marks]

1.17 An error correcting code has the following code words: 00000000, 00001111, 01010101, 10101010, 11110000. What is the maximum number of bit errors that can be corrected ?

(a) 0 (b) 1
(c) 2 (d) 3

[2007 : 2 Marks]

1.18 In the waveform (a) given below, a bit stream is encoded by Manchester encoding scheme. The same bit stream is encoded in a different coding scheme in wave form (b). The bit stream and the coding scheme are



(a) 1000010111 and Differential Manchester respectively
(b) 0111101000 and Differential Manchester respectively
(c) 1000010111 and Integral Manchester respectively
(d) 0111101000 and Integral Manchester respectively

[2007 : 2 Marks]

1.19 Let us consider a statistical time division multiplexing of packets. The number of sources is 10. In a time unit, a source transmits a packet of 1000 bits. The number of sources sending data for the first 20 time units is 6, 9, 3, 7, 2, 2, 2, 3, 4, 6, 1, 10, 7, 5, 8, 3, 6, 2, 9, 5 respectively. The output capacity of multiplexer is 5000 bits per time unit. Then the average number of backlogged of packets per time unit during the given period is

(a) 5 (b) 4.45
(c) 3.45 (d) 0

[2007 : 2 Marks]

1.20 Your are given the following four bytes :

10100011 00110111 11101001 10101011

Which of the following are substrings of the base 64 encoding of the above four bytes?

(a) zdp (b) fpq
(c) qwA (d) oze

[2007 : 2 Marks]

1.21 How many bytes of data can be sent in 15 seconds over a serial link with baud rate of 9600 in asynchronous mode with odd parity and two stop bits in the frame?

(a) 10,000 bytes (b) 12,000 bytes
(c) 15,000 bytes (d) 27,000 bytes

[2008 : 1 Mark]

1.22 A 1 Mbps satellite link connects two ground stations. The altitude of the satellite is 36,504 km and speed of the signal is 3×10^8 m/s. What should be the packet size for a channel utilization of 25% for a satellite link using go-back-127 sliding window protocol?

Assume that the acknowledgment packets are negligible in size and that there are no errors during communication.

(a) 120 bytes (b) 60 bytes
(c) 240 bytes (d) 90 bytes

[2008 : 2 Marks]

1.23 Data transmitted on a link uses the following 2D parity scheme for error detection:

Each sequence of 28 bits is arranged in a 4 × 7 matrix (rows r_0 through r_3, and columns d_7 through d_1) and is padded with a column d_0 and row r_4 of parity bits computed using the Even parity scheme. Each bit of column d_0 (respectively, row r_4) gives the parity of the corresponding row (respectively, column). These 40 bits are transmitted over the data link.

	d_7	d_6	d_5	d_4	d_3	d_2	d_1	d_0
r_0	0	1	0	1	0	0	1	1
r_1	1	1	0	0	1	1	1	0
r_2	0	0	0	1	0	1	0	0
r_3	0	1	1	0	1	0	1	0
r_4	1	1	0	0	0	1	1	0

The table shows data received by a receiver and has n corrupted bits. What is the minimum possible value of n?

(a) 1 (b) 2
(c) 3 (d) 4

[2008 : 2 Marks]

1.24 Let G(x) be the generator polynomial used for CRC checking. What is the condition that should be satisfied by G(x) to detect odd number of bits in error?

(a) G(x) contains more than two terms
(b) G(x) does not divide $1 + x^k$, for any k not exceeding the frame length
(c) 1 + x is a factor of G(x)
(d) G(x) has an odd number of terms

[2009 : 2 Marks]

Linked Answer for Q.1.25 and Q. 1.26

Frames of 1000 bits are sent over a 10^6 bps duplex link between two hosts. The propagation time is 25 ms. Frames are to be transmitted into this link to maximally pack them in transit (within the link).

1.25 What is the minimum number of bits (l) that will be required to represent the sequence numbers distinctly? Assume that no time gap needs to be given between transmission of two frames.

(a) $l = 2$ (b) $l = 3$
(c) $l = 4$ (d) $l = 5$

[2009 : 2 Marks]

1.26 Suppose that the sliding window protocol is used with the sender window size of 2^l, where l is the number of bits identified in the earlier part and acknowledgments are always piggy backed. After sending 2^l frames, what is the minimum time the sender will have to wait before starting transmission of the next frame? (Identify the closest choice ignoring the frame processing time).

(a) 16 ms (b) 18 ms
(c) 20 ms (d) 22 ms

[2009 : 2 Marks]

1.27 In the following pairs of OSI protocol layer/sub-layer and its functionality, the **INCORRECT** pair is

(a) Network layer and Routing
(b) Data Link Layer and Bit synchronization
(c) Transport layer and End-to-end process communication
(d) Medium Access Control sub-layer and Channel sharing

[2014 (Set-3) : 1 Mark]

1.28 A bit-stuffing based framing protocol uses an 8-bit delimiter pattern of 01111110. If the output bit-string after stuffing is 01111100101, then the input bit-string is

(a) 0111110100 (b) 0111110101
(c) 0111111101 (d) 0111111111

[2014 (Set-3) : 1 Mark]

1.29 Suppose that the stop-and-wait protocol is used on a link with a bit rate of 64 kilobits per second and 20 milliseconds propagation delay. Assume that the transmission time for the acknowledgment and the processing time at nodes are negligible. Then the minimum frame size in bytes to achieve a link utilization of at least 50% is _________.

[2015 (Set-1) : 2 Marks]

1.30 A link has a transmission speed of 10^6 bits/sec. It uses data packets of size 1000 bytes each. Assume that the acknowledgment has negligible transmission delay, and that its propagation delay is the same as the data propagation delay. Also assume that the processing delays at nodes are negligible. The efficiency of the stop-and-wait protocol in this setup is exactly 25%. The value of the one-way propagation delay (in milliseconds) is ___________.

[2015 (Set-2) : 1 Mark]

1.31 Consider a network connecting two systems located 8000 kilometers apart. The bandwidth of the network is 500×10^6 bits per second. The propagation speed of the media is 4×10^6 meters per second. It is needed to design a Go-Back-N sliding window protocol for this network. The average packet size is 10^7 bits. The network is to be used to its full capacity.

Assume that processing delays at nodes are negligible. Then, the minimum size in bits of the sequence number field has to be ______.

[2015 (Set-3) : 2 Marks]

1.32 Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same. If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is _________.

[2015 (Set-3) : 2 Marks]

1.33 Consider two hosts X and Y connected by a single direct link of rate 10^6 bits/sec. The distance between the two hosts is 10,000 km and the propagation speed along the link is 2×10^8 m/sec. Host X sends a file of 50,000 bytes as one large message to host Y continuously. Let the transmission and propagation delays be p milliseconds and q milliseconds, respectively.

Then the values of p and q are

(a) $p = 50$ and $q = 100$
(b) $p = 50$ and $q = 400$
(c) $p = 100$ and $q = 50$
(d) $p = 400$ and $q = 50$

[2017 (Set-2) : 2 Marks]

■■■■

Answers ISO/OSI Stack and SWP

1.1	(b)	1.2	(a)	1.3	(b)	1.4	(c)	1.5	(d)	1.6	(c)	1.7	(b)	1.8	(a)	1.9	(b)
1.10	(a)	1.11	(d)	1.12	(c)	1.13	(b)	1.14	(b)	1.15	(c)	1.16	(b)	1.17	(b)	1.18	(c)
1.19	(b)	1.20	(b)	1.21	(b)	1.22	(a)	1.23	(c)	1.24	(c)	1.25	(d)	1.26	(b)	1.27	(b)
1.28	(b)	1.33	(d)														

Explanations ISO/OSI Stack and SWP

1.1 (b)

Given

Window size

n = 5 packets

Packet size = 1000 byte

Total packet size = 5 × 1000 = 5000 bytes

Total time = Transmission Time + Propagation Time

$= 5 \times 50 + 200\ \mu s$

$= 250 + 200\ \mu s$

$= 450\ \mu s$

$= 450 \times 10^{-6}$ s

Maximum Achievable throughput

$$= \frac{\text{Total Size}}{\text{Total Time}}$$

$$= \frac{5000}{450 \times 10^{-6}}$$

$$= \frac{5000 \times 10^6}{450}$$

$= 11.11 \times 10^6$ bps

1.2 (a)

P. Datal link layer:

1. Ensures reliable transport of data over a physical point-to point link- Reliable mens error correction & detection done by Data link layer.

Q. Network layer:

4. Routes data from one network node to the next according to routing algorithm.

R. Transport layer:

3. Allows end-to- end communication between two processes with the help of TCP and UDP protocol.

1.3 (b)

Total number of bits = 12

modulation Rate = 9600 baud

Number of characters (8 bit character) are transmitted = 9600/12bits = 800

1.4 (c)

In serial transmission T_1 :

To send 1 character = 8 bit data + 1 + 2 + 1 + 1

= 12 bits

$$\text{So transfer rate} = \frac{1200 \text{ bits/sec}}{12 \text{ bits}}$$

= 100 character/sec

In synchronous transmission T_2 :

To send 30 eight bit = 30 × 8 = 240 bits

Synchronize character = 3 × 8 = 24 bits

So, to send 30 eight bit data = 240 + 24 = 264 bits

So, Transfer rate (for 30 char)

$$= \frac{1200 \text{ bits/sec}}{264 \text{ bits}}$$

= 4.545 (30 char/sec)

So, In per character = 4.545 × 30

= 136.2 character/sec

1.5 (d)

Frame delimiter flag = 0111

- If we put 0 after first 1 i.e. 01011, there is very high probability that in message 1 followed by 0, so need, two many bits to transmit data.
- So we need to put 0 after two 1 followed by 0 i.e., 01101

  Hence data to be send = 0 1 1 0 1 0 1 1 0 0

1.6 (c)

In sliding window protocol :

Minimum number of sequence number = M + N

Since at any time number of unacknowledged frames are M at receiver and same time N packets are transmitted by sender.
So, M + N ≤ minimum sequence number.

1.7 (b)

Tx = 100*8 bits/20 Kbps = 40 ms
Tp = 400ms,
a = Tp / Tx = 400/40 = 10
Efficiency of GBN = W/(1 + 2a),
where w = window size
= 10 = 10/(1+20) = 10/21
BW utilization or throughput or max data rate = efficiency * BW = (10/21)*20
It is nearly 10 Kbps

1.8 (a)

Consider first 3 bits x_1, x_2 and x_3 are data bits and last 4 bits c_1, c_2, c_3 and c_4 are parity check bits i.e., 0101011 will be $x_1(0)$, $x_2(1)$, $x_3(0)$, $c_1(1)$, $c_2(0)$, $c_3(1)$ and $c_4(1)$.
By analysing pattern used to create parity bits i.e., here

	x_1	x_2	x_3	$c_1=x_1\oplus x_2$	$c_2=x_1\oplus x_3$	$c_3=x_2\oplus x_3$	$c_4=x_1\oplus x_2\oplus x_3$
1.	0	1	0	1	0	1	1
2.	1	0	0	1	1	0	1
3.	1	1	1	0	0	0	1

So by applying same rule to find other code words.

	x_1	x_2	x_3	$c_1=x_1\oplus x_2$	$c_2=x_1\oplus x_3$	$c_3=x_2\oplus x_3$	$c_4=x_1\oplus x_2\oplus x_3$
4.	0	0	1	0	1	1	1
5.	0	1	1	$1\neq 0$ so fail			
6.	1	0	1	1	0	1	0
7.	0	1	1	1	$1\neq 0$ so fail		

So only I[st] and III[rd] are code word.

1.9 (b)

In case of the selective Reject Protocol, the

maximum window size = $\frac{2^n}{2} = 2^{n-1}$

In the case of Selective Reject the window size will be half.

1.10 (a)

Generator polynomial is of degree 5 so append 5 0's to the end of data and then divide new data by generator polynomial $x^5 + x^4 + x^2 + 1$ = 110101.

```
110101 ) 101000110100000 (
         110101
         ------
          0111011
           110101
          -------
           0111011
            110101
           -------
            00111110
              110101
            --------
              00101100
                110101
              --------
                0110010
                 110101
                -------
                 0001110
```

Remainder is 01110

1.11 (d)

Propagation time = 20 m sec
Bandwidth = 4 Kbps
When efficiency is atleast 50%, then

$$T.T. \geq 2\ P.T.$$

$$\frac{x}{4\text{ kbps}} \geq 2 \times 20\text{ msec}$$

$$x \geq 2 \times 20 \times 10^{-3} + 4 \times 10^3\text{ bits}$$

$$x \geq 40 \times 4\text{ bits}$$

$$x \geq 160\text{ bits}$$

1.12 (c)

With 5 bits total number of encoding = $2^5 = 32$
Condition :

Case : 1 When [0] 1 0/1 0/1 [1] = 2^2 = 4 encoding

Case : 2 When [1] 0/1 0/1 0/1 [1] = 2^3 = 8 encoding

Case : 3 When [0] 1 0/1 1 [0] = 2 encoding

Case : 4 When [1] 0/1 0/1 1 [0] = 2^2 = 4 encoding

So total encoding = 8 + 4 + 2 + 4
= 18 encoding

1.13 (b)

In sliding window protocol (stop and wait) :
Average number of transmission of single packet

$= \left(\frac{1}{1-P}\right)$ (where P = probability of packet error).

So for 100 packets $= 100 \times \left(\frac{1}{1-0.2}\right)$

$$= 100 \times \frac{1}{0.8} = 125$$

1.30 Sol.

$$\text{Efficiency of Stop \& Wait} = \frac{1}{1+2a}$$

$$\Rightarrow \quad 0.25 = \frac{1}{1+2a}$$

$$a = \frac{p_d}{t_d}, \; t_d = 8 \text{ ms}$$

$$\therefore \; 0.25 = \frac{1}{1+2\times\frac{p_d}{8\text{ms}}} \Rightarrow p_d = 12 \text{ ms}$$

1.31 Sol.

$$d = 8000 \text{ km}$$

$$\text{Band width} = 500 \times 10^6 \text{ bps}$$

Propagation delay

$$P_d = \frac{8000\times10^3}{4\times10^6} = 2 \text{ sec}$$

$$\text{Packet size} = 10^7 \text{ bits}$$

Transmission delay

$$t_d = \frac{10^7}{500\times10^6} = \frac{1}{50} \text{ sec}$$

$$n = 100\%$$

$$\frac{100}{100} = \frac{N}{1+2a}$$

$$a = \frac{P_d}{t_d} = \frac{2}{1/50}\text{sec} = 100$$

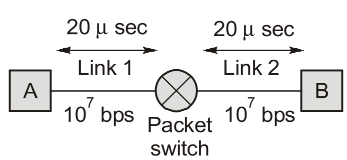
$$\frac{100}{100} = \frac{N}{201}$$

$$N = 201$$

⇒ Number of packets = 201

∴ 8 bits are required for sequence number.

1.32 Sol.



Extra delay at switch = 35 μsec for each packet.

Data = 10000 bits

$$\text{Number of packets} = \frac{10000}{5000} = 2 \text{ packet}$$

Transmission delay for one packet = 500 μsec.

At ***t* = 500** μsec, last bit of packet 1 is placed on link 1 by A and Transmission of packet begins.

At ***t* = 520**, last bit of packet 1 reaches switch.

At ***t* = 555**, first bit of packet 1 is placed on link 2 by switch.

At ***t* = 1000**, last bit of packet 2 is placed on link 1 by A.

At ***t* = 1020**, last bit of packet 2 reaches switch.

Note: pkt 2 need to wait upto 1055 μsec before switch transfers it.

Last bit of packet1 will be placed on link 2 by switch at 1055 μsec.

Hence No additional delay for packet 2.

At ***t* = 1055** packet two first bit is placed on link 2.

At ***t* = 1575** last bit of packet 2 reaches B.

∴ 1575 μsec is required.

1.33 (d)

$$\text{Transmission time} = \frac{\text{Data size}}{\text{Bandwidth}}$$

$$= \frac{50000\times8 \text{ bits}}{10^6 \text{ bits/sec}} = 400 \text{ msec}$$

$$\text{Propagation time} = \frac{\text{Distance}}{\text{Velocity}}$$

$$= \frac{10000\times10^3 \text{ m}}{2\times10^8 \text{ m/sec}}$$

$$= 50 \times 10^{5-8} \text{ sec}$$

$$= 50 \text{ msec}$$

■■■■