VIT Vellore Institute of Technology (Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

Fall Semester 2024-25

Continuous Assessment Test – 1

SLOT: D1+TD1

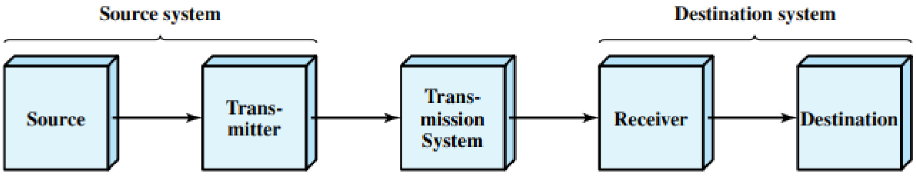
ANSWER KEY

Q.No.	Question	Max Marks
1.	(a) Explain the components of a communications model with the help of a suitable diagram.	5

ANSWER:

The components of a communications model are –

1. **Source**. This device generates the data to be transmitted; examples are telephones and personal computers.
2. **Transmitter**: Usually, the data generated by a source system are not transmitted directly in the form in which they were generated. Rather, a transmitter transforms and encodes the information in such a way as to produce electromagnetic signals that can be transmitted across some sort of transmission system. For example, a modem takes a digital bit stream from an attached device such as a personal computer and transforms that bit stream into an analog signal that can be handled by the telephone network.
3. **Transmission system**: This can be a single transmission line or a complex network connecting source and destination.
4. **Receiver**: The receiver accepts the signal from the transmission system and converts it into a form that can be handled by the destination device. For example, a modem will accept an analog signal coming from a network or transmission line and convert it into a digital bit stream.
5. **Destination**: Takes the incoming data from the receiver.



(b) A network uses a fully interconnected mesh topology to connect 10 nodes together. Considering full-duplex mode links, calculate the number of total links required and the number of I/O ports required in each node. 5

ANSWER:

For full-duplex mode, total $\frac{n(n-1)}{2}$ links are needed in mesh topology, where n is the number of nodes.

Hence, in this case, the total links required are $\frac{10(10-1)}{2} = 45$.

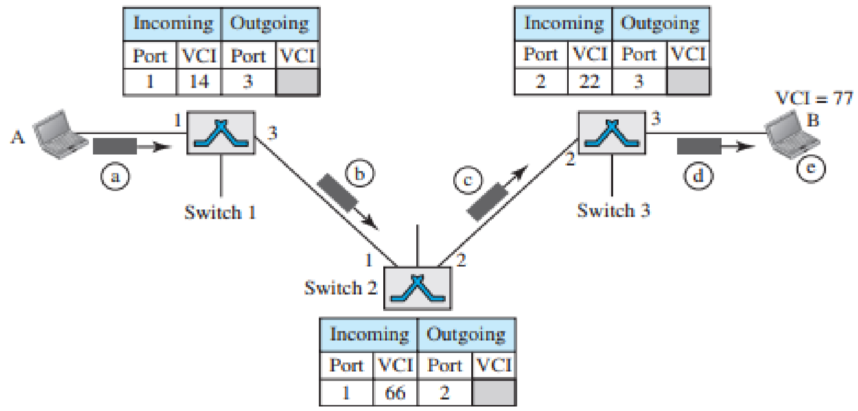
The number of I/O ports required in each node is $n - 1 = 10 - 1 = 9$.

2. Consider that the data is packetized before transmission and the endpoint devices do not have any technique to determine if the data is out of order. Which Switching will be suitable in this scenario and why? Explain the entire process for this switching using suitable diagrams. 10

ANSWER:
The data is packetized before transmission. Hence, it is a case of Packet Switching. In Datagram approach of Packet Switching, the packets may take different routes and can arrive at the receiver end out of order. As the endpoint devices do not have any technique to determine if the data is out of order, using Datagram approach will not be suitable here. The Virtual-Circuit approach will be suitable in this case.

In a virtual-circuit network, a source and destination need to go through three phases: setup, data transfer, and teardown. In the setup phase, the source and destination use their global addresses to help switches make table entries for the connection. In the teardown phase, the source and destination inform the switches to delete the corresponding entry. Data transfer occurs between these two phases.

1. **Setup Phase**: In the setup phase, a switch creates an entry for a virtual circuit. For example, suppose source A needs to create a virtual circuit to B. Two steps are required: the setup request and the acknowledgment.
   i. **Setup Request**: A setup request frame is sent from the source to the destination.
      a) Source A sends a setup frame to switch 1.
      b) Switch 1 receives the setup request frame. It knows that a frame going from A to B goes out through port 3. How the switch has obtained this information is a point covered in future chapters. The switch, in the setup phase, acts as a packet switch; it has a routing table which is different from the switching table. For the moment, assume that it knows the output port. The switch creates an entry in its table for this virtual circuit, but it is only able to fill three of the four columns. The switch assigns the incoming port (1) and chooses an available incoming VCI (14) and the outgoing port (3). It does not yet know the outgoing VCI, which will be found during the acknowledgment step. The switch then forwards the frame through port 3 to switch 2.
      c) Switch 2 receives the setup request frame. The same events happen here as at switch 1; three columns of the table are completed: in this case, incoming port (1), incoming VCI (66), and outgoing port (2).
      d) Switch 3 receives the setup request frame. Again, three columns are completed: incoming port (2), incoming VCI (22), and outgoing port (3).
      e) Destination B receives the setup frame, and if it is ready to receive frames from A, it assigns a VCI to the incoming frames that come from A, in this case 77. This VCI lets the destination know that the frames come from A, and not other sources.



ii. **Acknowledgment**: A special frame, called the acknowledgment frame, completes the entries in the switching tables.

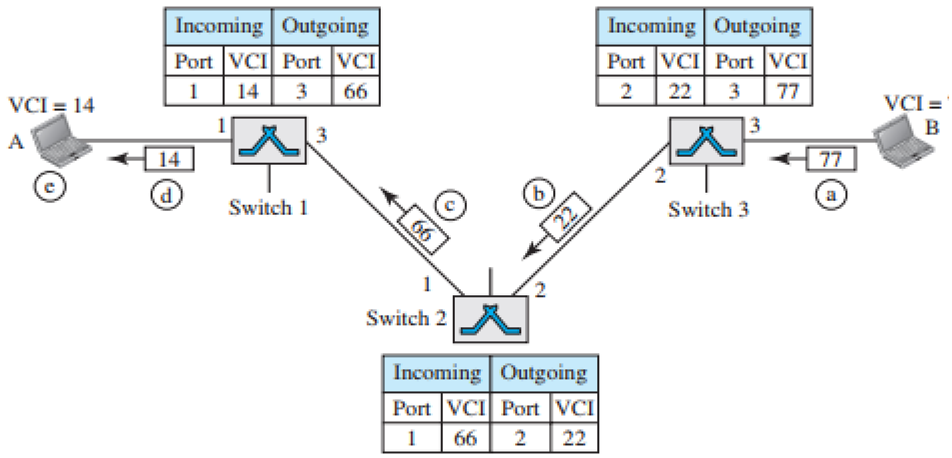
a) The destination sends an acknowledgment to switch 3. The acknowledgment carries the global source and destination addresses so the switch knows which entry in the table is to be completed. The frame also carries VCI 77, chosen by the destination as the incoming VCI for frames from A. Switch 3 uses this VCI to complete the outgoing VCI column for this entry. Note that 77 is the incoming VCI for destination B, but the outgoing VCI for switch 3.

b) Switch 3 sends an acknowledgment to switch 2 that contains its incoming VCI in the table, chosen in the previous step. Switch 2 uses this as the outgoing VCI in the table.

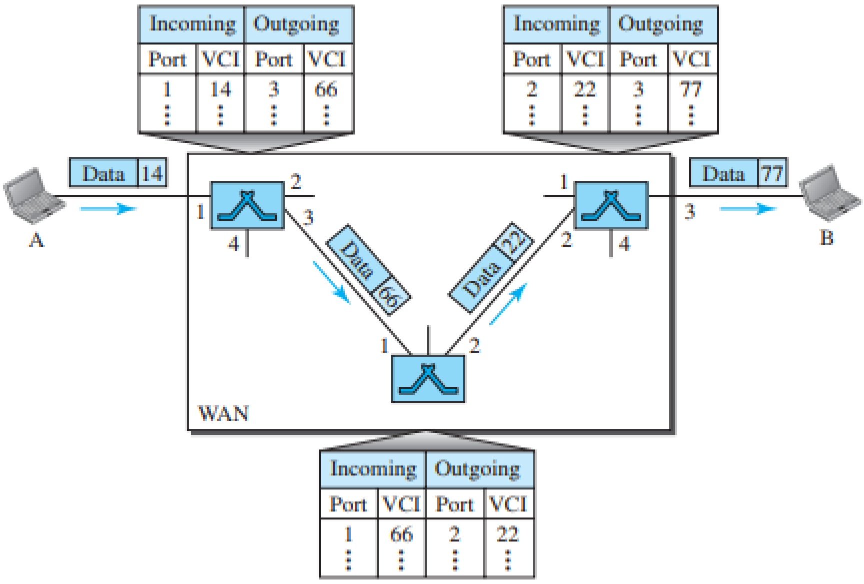
c) Switch 2 sends an acknowledgment to switch 1 that contains its incoming VCI in the table, chosen in the previous step. Switch 1 uses this as the outgoing VCI in the table.

d) Finally switch 1 sends an acknowledgment to source A that contains its incoming VCI in the table, chosen in the previous step.

e) The source uses this as the outgoing VCI for the data frames to be sent to destination B.



2. **Data Transfer Phase**: To transfer a frame from a source to its destination, all switches need to have a table entry for this virtual circuit. The table, in its simplest form, has four columns as seen in the setup phase. When a frame arrives at port 1 with a VCI of 14, the switch looks in its table to find port 1 and a VCI of 14. When it is found, the switch knows to change the VCI to 22 and send out the frame from port 3. The following figure shows how a frame from source A reaches destination B and how its VCI changes during the trip. Each switch changes the VCI and routes the frame.



3. **Teardown Phase**: In this phase, source A, after sending all frames to B, sends a special frame called a teardown request. Destination B responds with a teardown confirmation frame. All switches delete the corresponding entry from their tables.

3. (a) Define Bandwidth and Throughput in terms of Networking. Consider a system generating 20-bit frames and connected through a shared 20kbps channel. Find the throughput if the frame rate is 1000 fps. 5

ANSWER:
Bandwidth: The maximum amount of data that can be transmitted over a network connection in a given amount of time.
Throughput: The actual amount of data that is transmitted over a network connection in a given amount of time.

Throughput = (20 × 1000) bps = 20,000 bps = 20 kbps

(b) 30 Megabits data is sent from a source to destination 10,000 km apart. Bandwidth of the medium is 10Mbps. Propagation speed is 2x10^8 m/s. Processing time of the router is 0.01s. Determine the latency for the first packet. Calculate the Bandwidth-Delay product. 5

ANSWER:
Latency = Propagation Time + Transmission Time + Queuing Time + Processing Time

As it is the first packet, hence we can assume that there is no queuing time. Queuing Time = 0.

Propagation Time = $\frac{Distance}{Propagation\ Speed} = \frac{10000 \times 1000}{2 \times 10^8} s = 0.05s$

Transmission Time = $\frac{Message\ Size}{Bandwidth} = \frac{30 \times 10^6}{10^7} s = 3s$

Processing Time = 0.01s

Hence, Latency = (0.05 + 3 + 0 + 0.01) s = 3.06 s

4. Consider a dataword to be transmitted is 10010001. Determine the sent codewords for (i) even parity scheme (ii) odd parity scheme. During transmission, the codeword is modified to 101100111. Determine the Hamming distance between sent and received codewords for (i) even parity scheme (ii) odd parity scheme. Which parity scheme can detect the error? Justify your answer. 10

ANSWER:
Dataword = 10010001. Number of 1s in dataword = 3 (odd).
(i) Parity bit for even parity scheme = 1
Codeword for even parity scheme = 100100011
(ii) Parity bit for odd parity scheme = 0
Codeword for odd parity scheme = 100100010

Codeword received at the receiver end = 101100111
(i) Hamming Distance between sent and received codewords for even parity scheme is the number of changed bits between 100100011 and 101100111 = 2
(ii) Hamming Distance between sent and received codewords for odd parity scheme is the number of changed bits between 100100010 and 101100111 = 3

(i) Syndrome in case of even parity scheme for received codeword 101100111 = 0. Hence, error cannot be detected in this case.
(ii) Syndrome in case of odd parity scheme for received codeword 101100111 = 1. Hence, error is detected in this case.
Parity-check code can detect an odd number of errors. In case of even parity scheme, the Hamming Distance is 2 and hence 2 bits have changed. Even parity scheme cannot detect this even number of errors. In case of odd parity scheme, the Hamming Distance is 3 and hence 3 bits have changed. Odd parity scheme can detect this odd number of errors.

5. The message HELLO WORLD! has to be transferred. At the sender end, determine the internet checksum and the transmitted data. How does the receiver conclude that there is no error in the received message? Show the calculations at the receiver end if there are no errors. [P.T.O for ASCII-Hexadecimal table] 10

Symbol	A	B	C	D	E	F	G	H
Hex Value	41	42	43	44	45	46	47	48
Symbol	I	J	K	L	M	N	O	P
Hex Value	49	4A	4B	4C	4D	4E	4F	50
Symbol	Q	R	S	T	U	V	W	X
Hex Value	51	52	53	54	55	56	57	58
Symbol	Y	Z	<space>	!				
Hex Value	59	5A	20	21				

ANSWER:
Converting HELLO WORLD! To hex values, we get
48 45 4C 4C 4F 20 57 4F 52 4C 44 21

At the sender end, to determine the internet checksum (16 bit), we perform the following operation –

1	3	1	2		←Carry
	4	8	4	5	
	4	C	4	C	
	4	F	2	0	
	5	7	4	F	
	5	2	4	C	
+	4	4	2	1	
	D	1	6	D	
+				1	
	D	1	6	E	←Sum
	2	E	9	1	←Checksum

Transmitted Data = 48 45 4C 4C 4F 20 57 4F 52 4C 44 21 2E 91

The receiver calculates the checksum for the received data. If the checksum is 0, then it concludes that there is no error. Otherwise, there is error.

At the receiver end, to determine the internet checksum (16 bit), we perform the following operation –

1	3	1	2		←Carry
	4	8	4	5	
	4	C	4	C	
	4	F	2	0	
	5	7	4	F	
	5	2	4	C	
	4	4	2	1	
+	2	E	9	1	
	F	F	F	E	
+				1	
	F	F	F	F	←Sum
	0	0	0	0	←Checksum