Q1

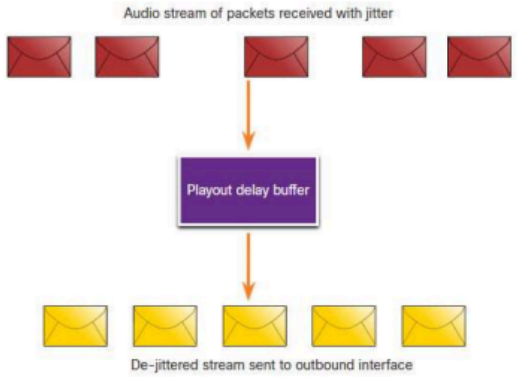
1. (i) "Without Quality of Service (QoS), network devices will forward all packets during congestion". Do you agree with this statement? Appraise this statement. (5 marks)

Network Transmission Quality

Packet Loss

Without QoS mechanisms, time-sensitive packets, such as real-time video and voice, are dropped with the same frequency as data that is not time-sensitive.

- When a router receives a Real-Time Protocol (RTP) digital audio stream for Voice over IP (VoIP), it compensates for the jitter that is encountered using a playout delay buffer.
- The playout delay buffer buffers these packets and then plays them out in a steady stream.



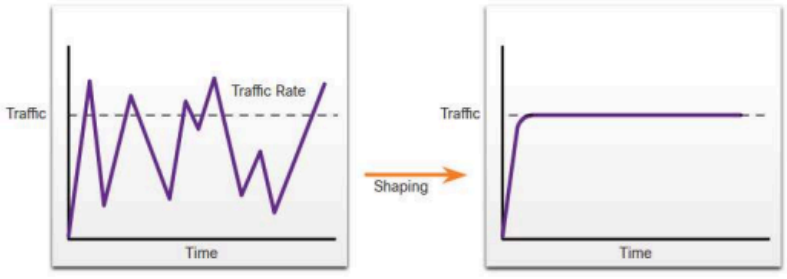
(ii) Two mechanisms provided by Cisco IOS QoS software to prevent congestion are Traffic shaping and traffic policing. Differentiate these mechanisms. (8 marks)

QoS Implementation Techniques

Shaping and Policing

Traffic shaping and traffic policing are two mechanisms provided by Cisco IOS QoS software to prevent congestion.

- Traffic shaping retains excess packets in a queue and then schedules the excess for later transmission over increments of time. Traffic shaping results in a smoothed packet output rate.
- Shaping is an outbound concept; packets going out an interface get queued and can be shaped. In contrast, policing is applied to inbound traffic on an interface.



QoS Implementation Techniques

Shaping and Policing (Cont.)

Policing is applied to inbound traffic on an interface. Policing is commonly implemented by service providers to enforce a contracted customer information rate (CIR). However, the service provider may also allow bursting over the CIR if the service provider's network is not currently experiencing congestion.

Q2

2. A network engineer is selecting a QoS method to control congestion on a VPN tunnel link between the headquarters site and a branch office. Which queuing method cannot be used to classify and control VPN traffic? Give your explanation.

Q3

3. Compare the characteristics of voice, video, and data traffic for QoS using the following table.

Voice	Video	Data

Q4

4. List three tools for implementing QoS and give TWO (2) explanations for each of the tools.

Tools	Explanation

Q5

5. Compare the following queueing algorithms:
   (i) First-In, First-Out (FIFO)
   (ii) Weighted Fair Queuing (WFQ)
   (iii) Class-Based Weighted Fair Queuing (CBWFQ)
   (iv) Low Latency Queuing (LLQ)

i)

Queuing Algorithms

First in First Out

- First In First Out (FIFO) queuing buffers and forwards packets in the order of their arrival.
- FIFO has no concept of priority or classes of traffic and consequently, makes no decision about packet priority.
- There is only one queue, and all packets are treated equally.
- Packets are sent out an interface in the order in which they arrive.

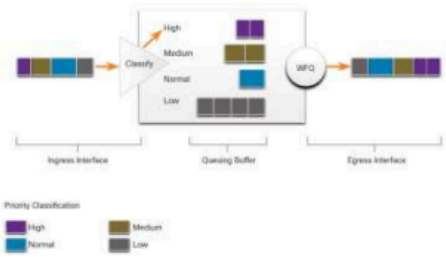
ii)

Queuing Algorithms

Weighted Fair Queuing (WFQ)

Weighted Fair Queuing (WFQ) is an automated scheduling method that provides fair bandwidth allocation to all network traffic.

- WFQ applies priority, or weights, to identified traffic, classifies it into conversations or flows, and then determines how much bandwidth each flow is allowed relative to other flows.
- WFQ classifies traffic into different flows based on source and destination IP addresses, MAC addresses, port numbers, protocol, and Type of Service (ToS) value.
- WFQ is not supported with tunneling and encryption because these features modify the packet content information required by WFQ for classification.



iii)

Queuing Algorithms

Class-Based Weighted Fair Queuing (CBWFQ)

Class-Based Weighted Fair Queuing (CBWFQ) extends the standard WFQ functionality to provide support for user-defined traffic classes.

- Traffic classes are defined based on match criteria including protocols, access control lists (ACLs), and input interfaces.
- Packets satisfying the match criteria for a class constitute the traffic for that class.
- A FIFO queue is reserved for each class, and traffic belonging to a class is directed to the queue for that class.
- A class can be assigned characteristics, such as bandwidth, weight, and maximum packet limit. The bandwidth assigned to a class is the guaranteed bandwidth delivered during congestion.
- Packets belonging to a class are subject to the bandwidth and queue limits, which is the maximum number of packets allowed to accumulate in the queue, that characterize the class.

iv)

Queuing Algorithms

Low Latency Queuing (LLQ)

The Low Latency Queuing (LLQ) feature brings strict priority queuing (PQ) to CBWFQ.

- Strict PQ allows delay-sensitive packets such as voice to be sent before packets in other queues.
- LLQ allows delay-sensitive packets such as voice to be sent first (before packets in other queues), giving delay-sensitive packets preferential treatment over other traffic.
- Cisco recommends that only voice traffic be directed to the priority queue.