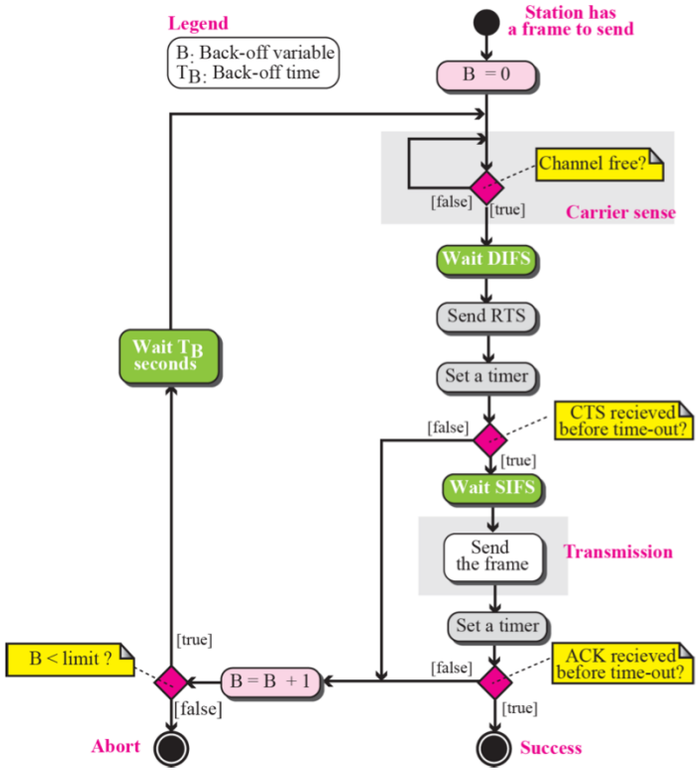
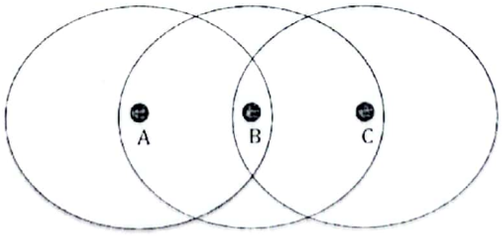
Q1. (6 marks)

1. Represent and briefly describe the algorithm of CSMA/CA for MAC sublayer

CSMA/CA flow diagram



The figure below shows three wireless nodes and their transmission ranges.



2. Use this figure to explain the concept of "hidden node" problem in wireless communication.

Hidden terminals are senders that cannot sense each other but nonetheless collide at intended receiver

- Want to prevent; loss of efficiency
- A and C are hidden terminals when sending to B

CamScanner

D) Carrier sense mutipk Access / Collision Avoidnce is a Protocol for Carrier transmission in 802.11 networks.

Station ready to send start sensing the medium

If the medium is free for the duration of IFS, the station can start sending

If the medium is busy, the station has to wait for a free IFS then must wait for a random back-off time

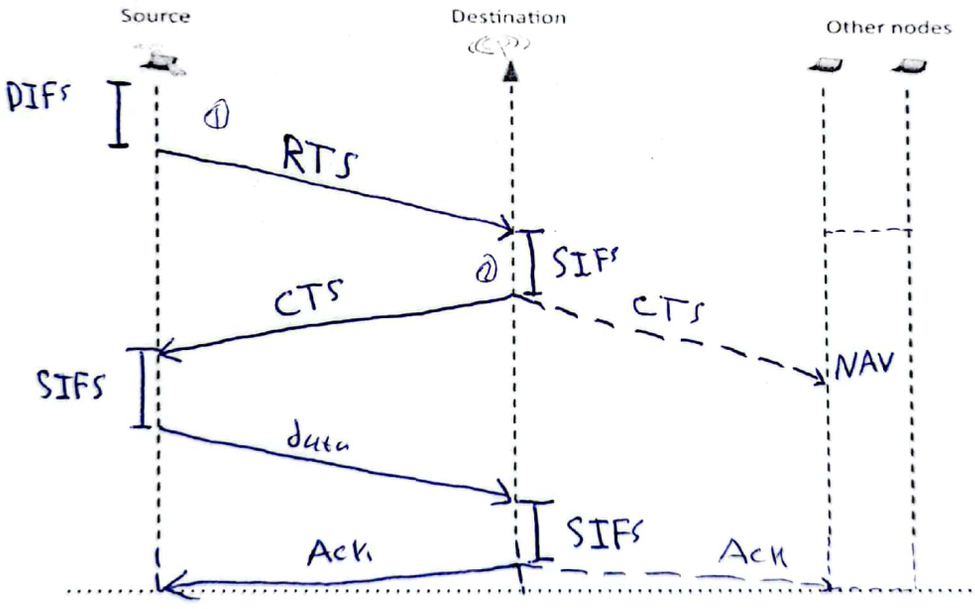
If another station occupies the medium during the back off time of the station the back off timer stops.

CamScanner

Hidden nodes are senders that cannot sense each other but collide at intended receiver

A, C are hidden nodes when sending to B

3. Use an exchange diagram (as represented below) to explain how CSMA/CA protocol can resolve this problem with the use of RTS/CTS and NAV. For your explanation, assume that the source wants to send a frame to the destination.



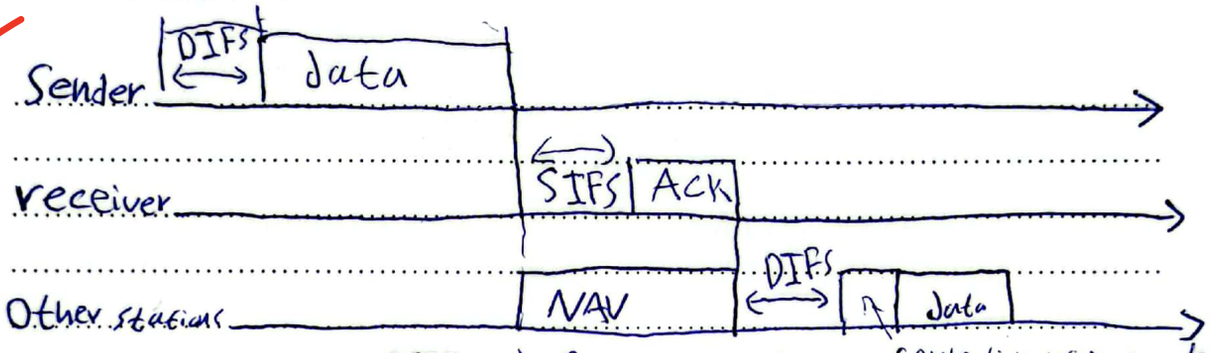
The CTS Frame in CSMA/CA handshake can prevent collision from a hidden station

CamScanner

4. The exchange of RTS/CTS in the CSMA/CA reduces the efficient throughput in the wireless network. Explain how?

The receiving node has to send CTS signal to all the neighbour nodes. So they have to wait before sending the data which causes neighbours to undergo exponential back off algorithm which is increasing wait time and can also result into decrement in throughput.

5. Explain with a diagram how CSMA/CA uses different inter-frame spaces to avoid collusion?



- Station has to wait DIFS before sensing data
- receiver sends Ack after waiting SIFS if the packet received correctly (CRC)
- Automatic retransmission of data packet in case of transmission error

6. Explain the main difference between FDMA and TDMA

In FDMA, the available bandwidth of the common channel is devided into bands that are separated by guard bands

In TDMA, the bandwidth is just one channel that is timeshared between different stations

CamScanner

Q2. (4 marks)

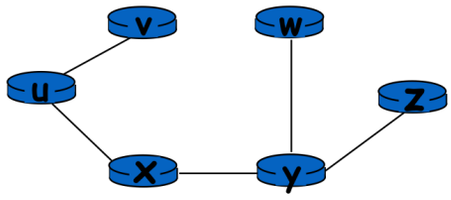
1. Explain the difference between routing and forwarding processes of packets.

forwarding: move packets from router's input to the appropite router's output

Routing: determine the path taken by packets from source host to the destination host

2. Explain how the packet at the input of the router are forwarded to the adequate output using the forwarding table

Each router contains a forwarding table. the forwarding table has a header value feild and an output link field. when a packet arrives at a router it checkes the header value of the router and the associated link to it. And send the packet to the associated output link with that header.



Resulting forwarding table in u:

destination	link
v	(u,v)
x	(u,x)
y	(u,x)
w	(u,x)
z	(u,x)

CamScanner

(4 marks)

Q3.

Consider a machine that has the IP address 192.168.92.10

1. Suppose that we are using class-based addressing. To which class of address belongs this IP address?

Class C

2. If the network is not divided into subnets. What is the network mask in this case?

255.255.255.0

3. If the network administrator had decided to break the network into 8 different subnets, what would the network mask?

1111 1111.1111 1111.1111 1111.1110 0000 = 255.255.255.224

4. How many machines can be connected for every subnet?

$2^5 - 2 = 30$ machines

CamScanner

Q4. (6 marks)

A.

Consider a wireless network using the CSMA/CA with RTS/CTS mechanism. We suppose that the propagation delay is α, SIFS is α, DIFS is 4α, and RTS and CTS are 6α respectively. α is a constant that is expressed in second.

1. Express using α, the earliest time for the receiver to send the CTS message?

$4\alpha + 6\alpha + \alpha + \alpha = 12\alpha$

2. If the data packet needs 100α to be transmitted, what is the shortest time for the receiver to send the ACK signal?

= DIFS + RTS + SIFS + CTS

$4\alpha + 6\alpha + \alpha + \alpha + 6\alpha + \alpha + \alpha + 100\alpha + \alpha + \alpha = 122\alpha$

3. A TDMA system uses 320 kbps data rate to support 8 users. What is the data rate provided for each user?

FDMA or

$\text{Data rate} = \text{each user}$

users

$\frac{320}{8} = 40$ Kbps

B.

Assume we send a file with a sliding window protocol from Riyadh to a host in Jeddah. We do not know exactly all the details of the sliding protocol, but we do know the following:

- The file is composed of n = 10 packets each one of a size L = 104 bits.

CamScanner

Assume transmission time of Ack is negligible

- The bit rate available for transmission is $R = 10^6$ bps.
- Assume that the propagation time is equal to T_{pr} sec

1. Assume that the sender uses a window size W = 1 packet. The destination sends one ack for every packet received. What is the minimum time it takes to transmit the file and receive all necessary acknowledgements? (give the expression using T_{pr})

transmission time = $\frac{104}{10^6} = 104 \times 10^{-6}$ s

Prob time 10 packets = $10 T_{pr}$

$10 \times (2T_{pr} + 104 \times 10^{-6}) = 20 T_{pr} + 104 \times 10^{-5}$ s

2. Suppose now that the window size W > n packets. What is the minimum time it takes to transmit the file and receive all necessary acknowledgements?

$10 \times 1.04 \times 10^{-6} + 11 T_{pr}$

CamScanner

1. Why the RTS and CTS are not used in CSMA/CD?
CSMA/CD stands Carrier Sense Multiple Access with Collision Detection, that means it provides different mechanisms and methods to detect collisions. RTS/CTS are used in wireless networks because wireless networks cannot detect the collision, hence, there has to be a way to maintain the communication collision free.

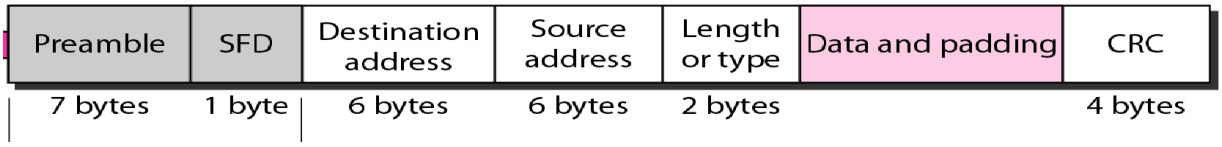
Define routing and forwarding?
Routing is the process of selecting a path for packets to travel in a network.
Forwarding: ….

Explain bellman ford algorithm?

Define the network mask?
*32-bit number of contiguous 1's followed by contiguous 0's.
To help to find the net ID and the host ID.*

What is the difference between slotted aloha and CSMA?
*Main difference between Aloha and CSMA is that Aloha protocol does not sense whether the channel is free before transmitting.
CSMA sense the channel if its free before transmitting data.*

Ethernet frame?

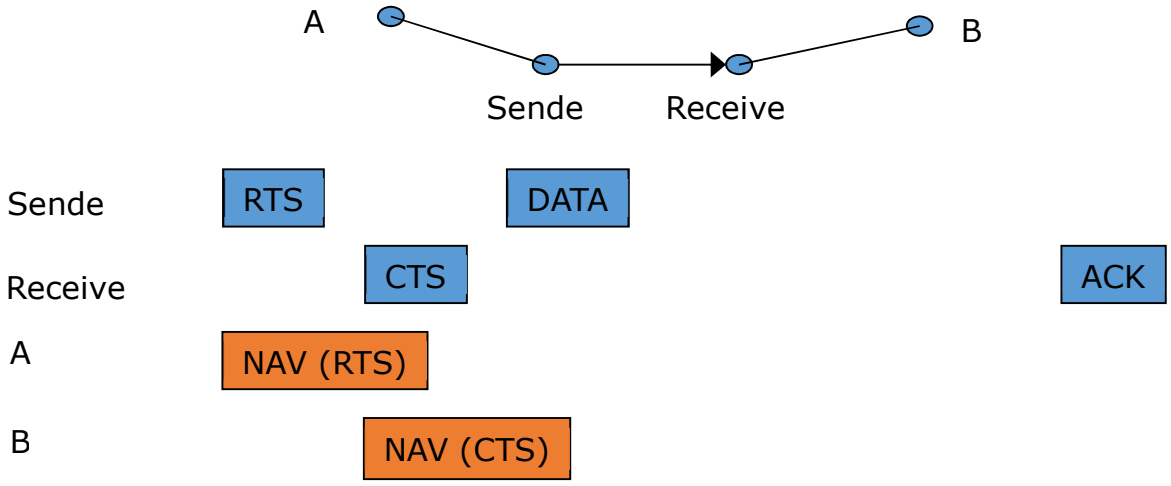


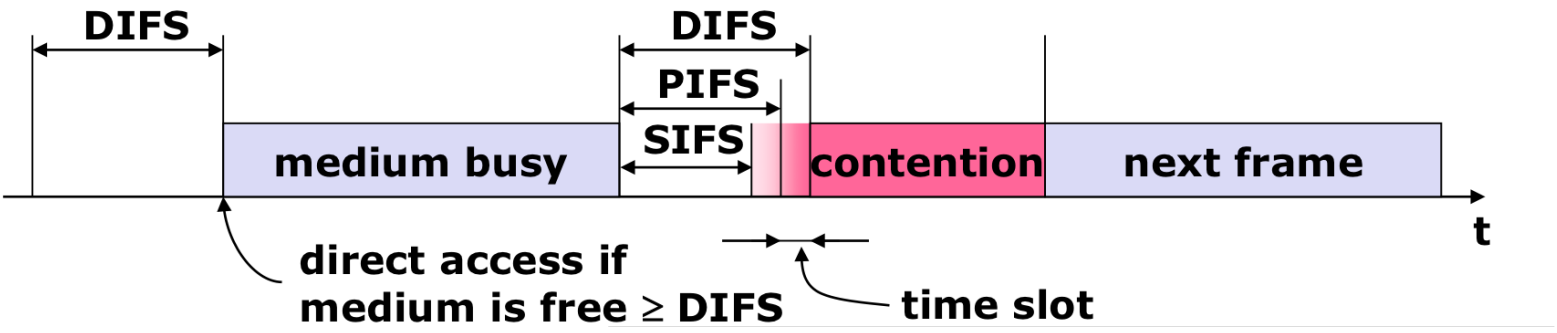
CRC→ binary division
Sender and receiver

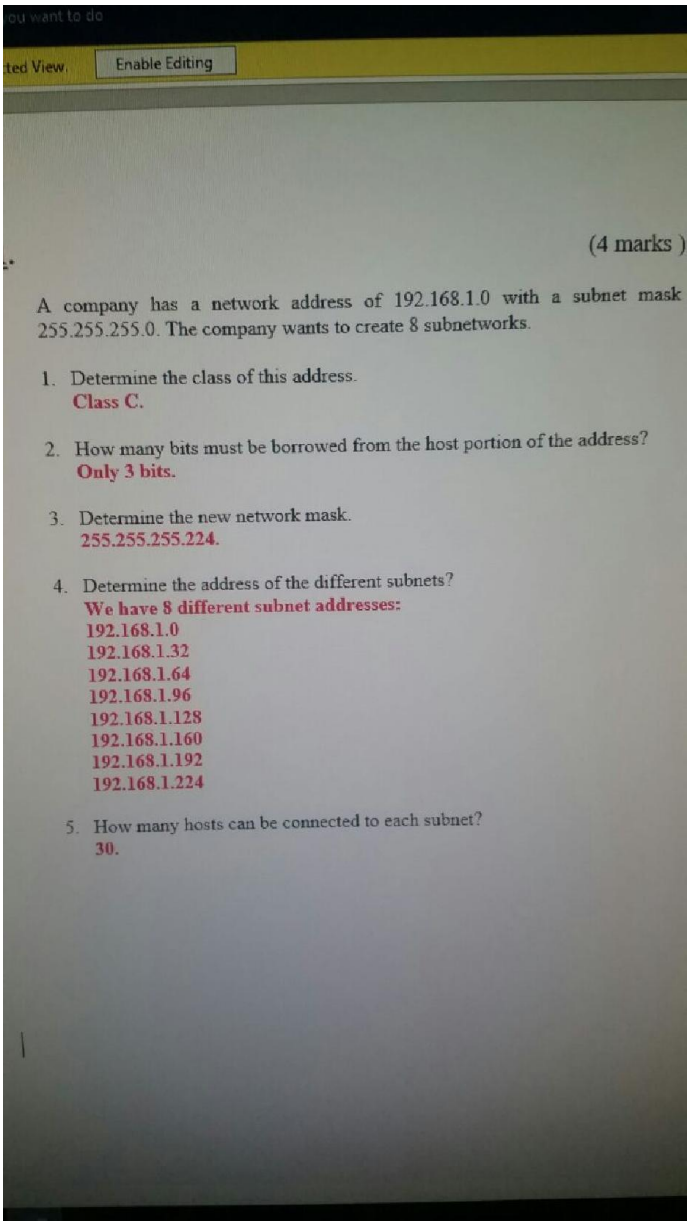
Slotted time in Ethernet ..given 10 mb

Max & Min Ethernet frame:
Minimum: 64 bytes (512 bits)
Maximum: 1518 bytes (12,144 bits)

Explain with a diagram how the CSMA/CA uses different inter frame between the frames?







(4 marks)

A company has a network address of 192.168.1.0 with a subnet mask 255.255.255.0. The company wants to create 8 subnetworks.

1. Determine the class of this address.
   Class C.

2. How many bits must be borrowed from the host portion of the address?
   Only 3 bits.

3. Determine the new network mask.
   255.255.255.224.

4. Determine the address of the different subnets?
   We have 8 different subnet addresses:
   192.168.1.0
   192.168.1.32
   192.168.1.64
   192.168.1.96
   192.168.1.128
   192.168.1.160
   192.168.1.192
   192.168.1.224

5. How many hosts can be connected to each subnet?
   30.

IP Address : 192.168.92.10

Class A : 0 - 127
Class B : 128 - 191
Class C : 192 - 223
class D : 224 - 239

(i) Given IP belong to class C

NID = 24 bit
HID = 8 bit

(ii) Network mask : 255.255.255.0
NID

(iii) Break into 8 subnet

# of Bit for subnetting from Host ID = $\lceil \log_2 8 \rceil = 3$

Subnet mask : 255.255.255.224

(iv) 11111111.11111111.11111111.111 00000
NID SID HID
NID

# of machine can be connected in each subnet $= 2^5 - 2 = 30$

↳ two reserved for subnet IP, Broadcast Address

King Saud University
College of Computer and Information Sciences
Computer Science Department

Course Code	CSC 329		
Course Title	Computer Networks		
Section No.			
Semester	S2 – Spring 21		
Exam	End semester exam		
Date	April, 20th 2021	**Duration**	120 min
Student Name			
Student ID			

Course Learning Outcomes		**Relevant question**	**Full mark**	**Student mark**
CLO 1	**The ability to describe major networking terms, topologies, types, protocols, devices, and components.**	NA		
CLO2	**The ability to explain the main services, type of addressing, and protocols associated with each layer of the OSI model.**	NA		
CLO 3	**The ability to recognize signal types, characteristics, impairments, encoding methods, transmission media.**	Q2 & Q4		
CLO 4	**The ability to recognize the functions and protocols of the data link layer (**framing, error control, flow control, medium access control.)	Q1, Q3 & Q4		
CLO 5	**The ability to explain the functions and protocols of the network layer and to describe the different routing approaches:** (datagram , VC , addressing, Routing).	Q2, Q3		
CLO 6	**The ability to compare the features of network components and to measure and analyze the time performances of a network.**	Q2, Q4		

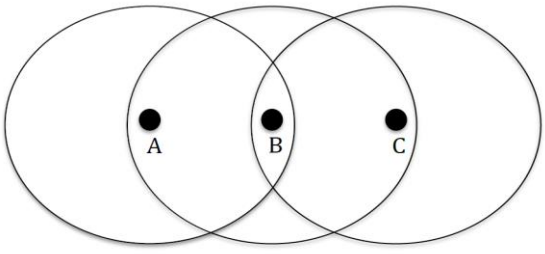
Feedback/Comments:

Q1. (6 marks)

1. Represent and briefly describe the algorithm of CSMA/CA for MAC sublayer

……
……
……
……
……
……
……
……
……
……
……
……
……
……
……

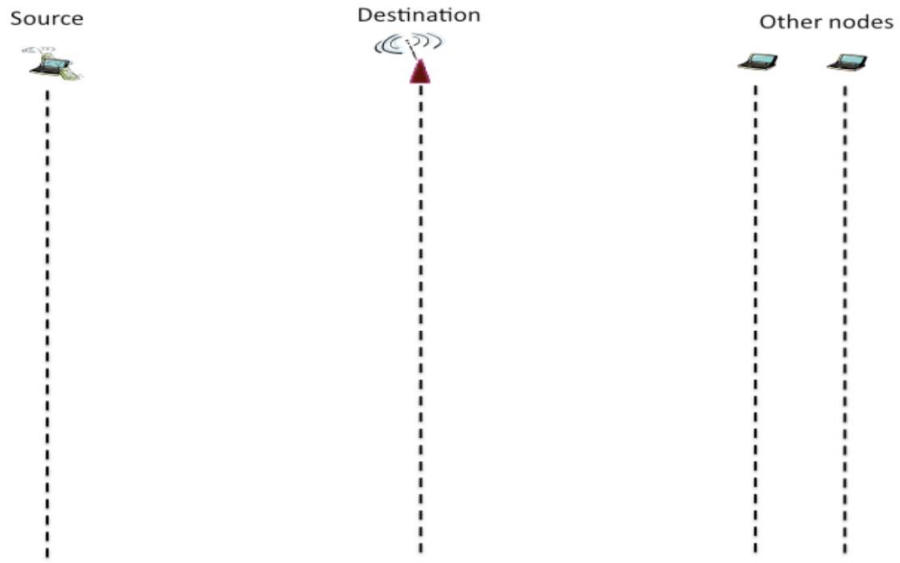
The figure below shows three wireless nodes and their transmission ranges.



2. Use this figure to explain the concept of "hidden node" problem in wireless communication.

……
……
……
……
……
……
……
……
……

3. Use an exchange diagram (as represented below) to explain how CSMA/CA protocol can resolve this problem with the use of RTS/CTS and NAV. For your explanation, assume that the source wants to send a frame to the destination.



……
……
……
……
……
……

4. The exchange of RTS/CTS in the CSMA/CA reduces the efficient throughput in the wireless network. Explain how?

……
……
……
……
……..

5. Explain with a diagram how CSMA/CA uses different inter-frame spaces to avoid collusion?

……
……
……
……
……
……
……
……

6. Explain the main difference between FDMA and TDMA

……
……
……
……
……
……
……
……

Q2. (4 marks)

1. Explain the difference between routing and forwarding processes of packets.

……
……
……
……
……
……
……
……

2. Explain how the packet at the input of the router are forwarded to the adequate output using the forwarding table

……
……
……
……
……
……
……
……
……

Q3. (4 marks)

Consider a machine that has the IP address 192.168.92.10

1. Suppose that we are using class-based addressing. To which class of address belongs this IP address?

……

……

2. If the network is not divided into subnets. What is the network mask in this case?

……

……

3. If the network administrator had decided to break the network into 8 different subnets, what would the network mask?

……

……

……..

4. How many machines can be connected for every subnet?

……

……

……

……

Q4. (6 marks)

A.

Consider a wireless network using the CSMA/CA with RTS/CTS mechanism. We suppose that the propagation delay is α, SIFS is α, DIFS is 4α, and RTS and CTS are 6α respectively. α is a constant that is expressed in second.

1. Express using α, the earliest time for the receiver to send the CTS message?

……
……
……
……
……

2. If the data packet needs 100α to be transmitted, what is the shortest time for the receiver to send the ACK signal?

……
……
……
……
……
……
……

3. A TDMA system uses 320 kbps data rate to support 8 users. What is the data rate provided for each user?

……
……
……

B.

Assume we send a file with a sliding window protocol from Riyadh to a host in Jeddah. We do not know exactly all the details of the sliding protocol, but we do know the following:

- The file is composed of n = 10 packets each one of a size L = 104 bits.

- The bit rate available for transmission is $R = 10^6$ bps.
- Assume that the propagation time is equal to T_{pr} sec

1. Assume that the sender uses a window size W = 1 packet. The destination sends one ack for every packet received. What is the minimum time it takes to transmit the file and receive all necessary acknowledgements? (give the expression using T_{pr})

……
……
……
……
……
……

2. Suppose now that the window size W ≥ n packets. What is the minimum time it takes to transmit the file and receive all necessary acknowledgements?

……
……
……

NETWORK – CSC329

Mid-1 Questions

1. **Define the concept of layer in communication architecture?**
   - Set of tasks implement separately to process data during communication.

2. **Define the concept of protocol?**
   - **Protocol** Is a set of rules that governs the exchange of data between two entities of the network.

3. **Name the seven layers defined in the ISO OSI Reference Model and state the functions of the lowest three layers?**
   - Layer 7: Application.
   - Layer 6: Presentation
   - Layer 5: Session
   - Layer 4: Transport
   - Layer 3: Network – is responsible for delivers of individual packets from source host to destination host.
   - Layer 2: Data link – is responsible of movements of frames from one hop to the next
   - Layer 1: Physical – is responsible of movements of bits from one hop to the next
4. **Give the Shannon's theorem that describes the data rate of a physical medium with respect to signal to noise ratio?**

5. **Calculate theoretical highest bit rate of a regular telephone line that has a bandwidth of 3000 hz. The signal to noise is 3162.**

   - C = B log2 (1 + SNR) = 3000 log2 (1 + 3162) = 3000 log2 3162

     = 3000 * 11.62 = 34,860 bps

6. **Explain the concept of bit staffing in bit-oriented synchronous transmission.**

   Stuffing done at the bit level:
   - Frame flag has six consecutive 1s (01111110)
   - On transmit, after five 1s in the data, a 0 is added
   - On receive, a 0 after five 1s is deleted

7. **Suppose the following bit string is received by the data link layer from the network layer: 01110111110111110111110. What is the resulting string after bit stuffing process?**
   - 011101111101111101111010

8. **A sender (S) wants to send a message M = 1010001101. It uses the CRC method to generate the frame check sequence FCS.**

   The used generator polynomial is given by $G(x) = X^5 + X^4 + X^2 + 1$.

   1. **Give the polynomial M(x) that represent the message M.**
      - $M(x) = X^9 + X^7 + X^3 + X^2 + 1$
   2. **Determine the sequence of bits (5 bits) that allows detecting errors**

2. **Determine the sequence of bits (5 bits) that allows detecting errors.**

3. **Represent the binary whole message (T) send by the sender (S).**

4. **How does the receiver check whether the message T was transmitted without any errors?**

9. **Briefly explain the difference between transmission time and propagation time.**
   - **Transmission time:** time to put M-bit message “on the wire”.
   - **Transmission time =** M (bit) / rate (bit/sec) = M/R seconds
   - **Propagation time:** time for bits to propagate across the wire.
   - **propagation time =** length / speed of signals = D seconds.

10. **Assume that two hosts, A and B are connected by a single link with rate R bps (bits per seconds). A and B are separated by m meters and the propagation speed along the link connecting them is s meters/seconds. Host A is sending a packet of L bits to host B. Ignoring processing and queuing time, obtain an expression for the end-to-end delay.**
    - Latency = M/R+D

Q1. (5 marks)

1. Define the concept of layer in communication architecture.

The Sender and resiver has a layer using for diveding the task into a sebset of tasks because take to each layel a spcail task to do it. and we have the tacnices to interface between the layer for each layer we have interface from the top and bottom to moving the data from/to the eather layer using the thropof. 1

2. Define the concept of protocol

the protocal is a set of rouls that comenction between layer to interface between them (interactive) 1

APSTNDP

3. Name the seven layers defined in the ISO OSI Reference Model and state the functions of the lowest three layers. 3

1) Physical layer : the layer conteictive to (bit by bit) AND moving data
2) Data link layer : the layer conteictive to (stream by stream) AND moving data
3) Network layer : the layer conteictive to (Packt by Packt) moving data
4) Transport layer
5) Seissaion layer
6) Presintion layer
7) Applection layer

Scanned with CamScanner

Q2. (5 marks)

A.

1. Give the Shannon's Theorem that describes the data rate of a physical medium with respect to signal to noise ratio.

~~bit rate = 2 * Bandwidth * log(1+SNR)~~

if we have a signal that have a noise in the phayscal medium we this change the bit rate of this signal

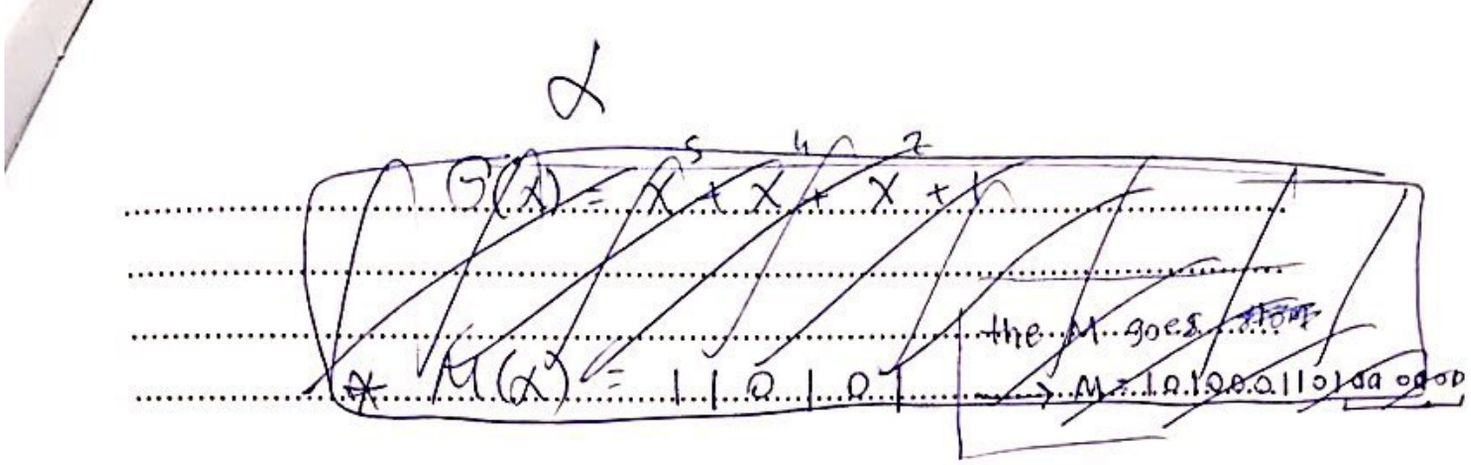
2. Calculate the theoretical highest bit rate of a regular telephone line that has a bandwidth of 3000 hz. The signal-to-noise ratio is 3162.

SNR

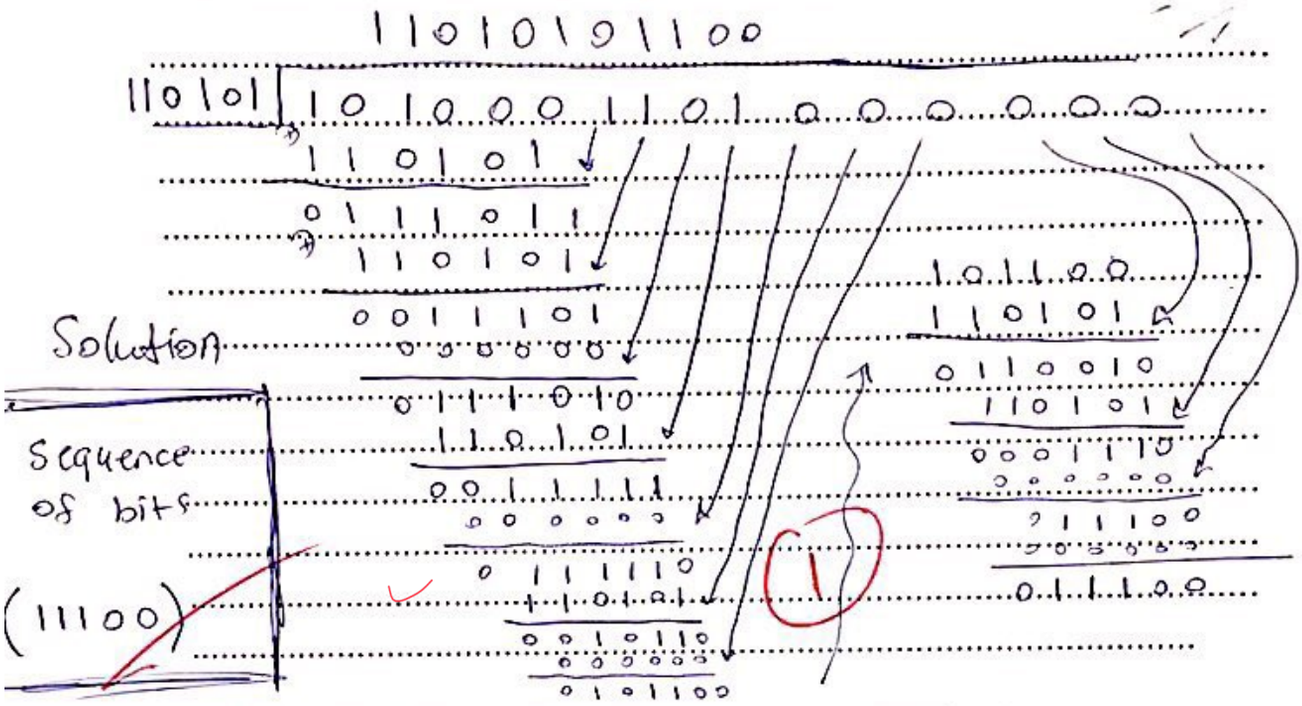
$$\text{bit rate} = 2 * \text{Bandwidth} * \log_2(\text{SNR})$$

$$= 21000 \text{ bps}$$

Scanned with CamScanner

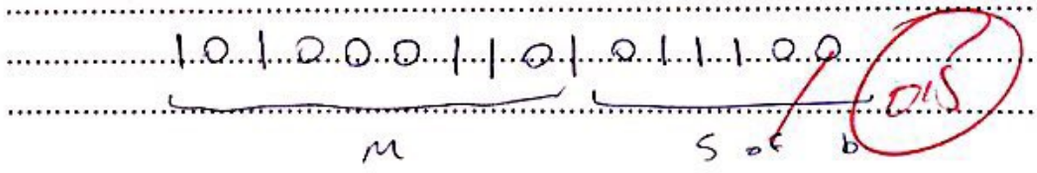


2. Determine the sequence of bits (5 bits) that allows detecting errors.



3. Represent the binary whole message (T) send by the sender (S).

Full M (M + sequence of bit)



4. How does the receiver check whether the message T was transmitted without any errors

After division the full message (T) by the polynomit we Generated (G(x)) if the remander is equle to 0's then we don't have any error

othwise

we have another (Getting by

Scanned with CamScanner

Q4. (5 marks)

1. Briefly explain the difference between transmission time and propagation time.

* The transmission time is the time we need to the data ~~trans~~ move from the first Medie (Sender Phaycal layer) to the last Medie (resived).

0.5

* The Propagation time is the time to constrict the data in Applection sender to ~~go~~ move to the Medie (Phaycal layer)

2. Assume that two hosts, A and B are connected by a single link with rate R bps (bits per second). A and B are separated by m meters and the propagation speed along the link connecting them is s meters/second. Host A is sending a packet of L bits to host B. Ignoring processing and queuing time, obtain an expression for the end-to-end delay.

$= \frac{R * L}{\text{Propastion speed}}$

3. We consider the sliding window protocol Figure 2. Does this figure indicate that Go-Back-N is being used or Selective Repeat is being used?

we use Selective Repeat

1

Scanned with CamScanner

B.

1. Explain the concept of bit stuffing in bit-oriented synchronous transmission.

the concept is we add flage bit tell (mean) of the start and finsh of data

2. Suppose the following bit string is received by the data link layer from the network layer: 01110111101111101111110. What is the resulting string after bit stuffing process?

the stuffing → after six 1's delete 0

0 1 1 1 0 1 1 1 1 0 1 1 1 1 1 0 1 1 1 1 1

Q3. (5 marks)

A sender (S) wants to send a message M = 1010001101. It uses the CRC method to generate the Frame Check Sequence FCS.

The used generator polynomial is given by $G(x) = x^5 + x^4 + x^2 + 1$.

1. Give the polynomial M(x) that represent the message M

$M(x) = x^9 + x^7 + x^3 + x^2 + 1$ (1)

Scanned with CamScanner

7. **Suppose the following bit string is received by the data link layer from the network layer: 01110111101111101111110. What is the resulting string after bit stuffing process?**

    011101111011111011111010

8. **A sender (S) wants to send a message M = 1010001101. It uses the CRC method to generate the frame check sequence FCS.**

    The used generator polynomial is given by G(x) = $X^5 + X^4 + X^2 + 1$.

    1. **Give the polynomial M(x) that represent the message M.**
        - $M(x) = X^9 + X^7 + X^3 + X^2 + 1$
    2. **Determine the sequence of bits (5 bits) that allows detecting errors.**
        -
    3. **Represent the binary whole message (T) send by the sender (S).**
    4. **How does the receiver check whether the message T was transmitted without any errors?**

9. **Briefly explain the difference between transmission time and propagation time.**

    - **Transmission time:** time to put M-bit message "on the wire".
    - **Transmission time** = M (bit) / rate (bit/sec) = M/R seconds
    - **Propagation time:** time for bits to propagate across

Scanned with CamScanner

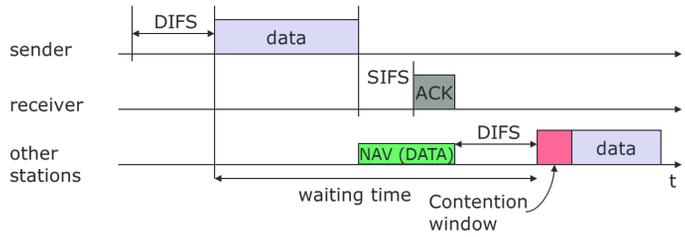
1. **Why the RTS and CTS are not used in CSMA/CD?**

   Because of hidden node problem in CSMA/CD -"occurs when a node is visible from a access point (AP), but not from other nodes communicating with that AP"

2. **Define routing?**

   Routing is the process of selecting a path for traffic in a network, or between or across multiple networks.

3. **Explain with a diagram how the CSMA/CA uses different inter frame between the frames?**



   - station has to wait for DIFS before sending data
   - receiver acknowledges at once (after waiting for SIFS) if the packet was received correctly (CRC)
   - automatic retransmission of data packets in case of transmission errors

4. **Explain bellman ford algorithm?**
   - $D_x(y)$ = estimate of least cost from x to y
   - Distance vector: $D_x = [D_x(y): y \in N]$
   - Node x knows cost to each neighbor v: c(x,v)
   - Node x maintains $D_x = [D_x(y): y \in N]$
   - Node x also maintains its neighbors' distance vectors
   - For each neighbor v, x maintains $D_v = [D_v(y): y \in N]$

5. **What is the role of ARP table?**

   We know that when two computers on the LAN want to communicate with each other the following will happen:

   - An IP packet is created with a source and destination IP address carrying the data from an application.
   - The IP packet will be encapsulated in an Ethernet frame with a source and destination MAC address.

   The sending computer will of course know its source MAC address but how does it know the destination MAC address? That's where ARP comes into play.[1]

   briefly: *To know the destination MAC address.*

[1] ARP (Address Resolution Protocol) explained

6. **Explain the ARP protocol?**
   - The ARP table is empty.
   - The source will send an ARP Request - Since we don't know the MAC address we will use the broadcast MAC address for the destination (FF:FF:FF:FF:FF:FF). This message will reach all computers in the network.
   - The destination will reply with a message ARP Reply - the source can now add the MAC address to its ARP table and start forwarding data towards the destination.

7. **Define the network mask?**

   - 32-bit number of contiguous 1's followed by contiguous 0's.
   - To help to find the net ID and the host ID.

8. **What is the difference between slotted aloha and CSMA?**

Main difference between Aloha and CSMA is that *Aloha* protocol does not try to detect whether the channel is free before transmitting but the *CSMA* protocol verifies that the channel is free before transmitting data.[2]

[2] Difference Between CSMA and ALOHA

1. Why the RTS and CTS are not used in CSMA/CD?
CSMA/CD stands Carrier Sense Multiple Access with Collision Detection, that means it provides different mechanisms and methods to detect collisions. RTS/CTS are used in wireless networks because wireless networks cannot detect the collision, hence, there has to be a way to maintain the communication collision free.

Define routing and forwarding?

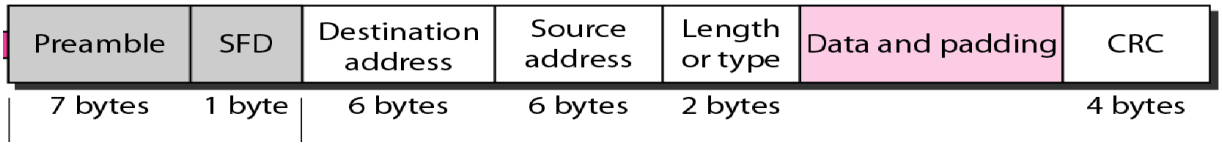
- *routing:* determine route taken by packets from source to dest.
- *forwarding:* move packets from router's input to appropriate router output

---

Define the network mask?
*32-bit number of contiguous 1's followed by contiguous 0's.
To help to find the net ID and the host ID.*

What is the difference between slotted aloha and CSMA?
*Main difference between Aloha and CSMA is that Aloha protocol does not sense whether the channel is free before transmitting.
CSMA sense the channel if its free before transmitting data.*

Ethernet frame?

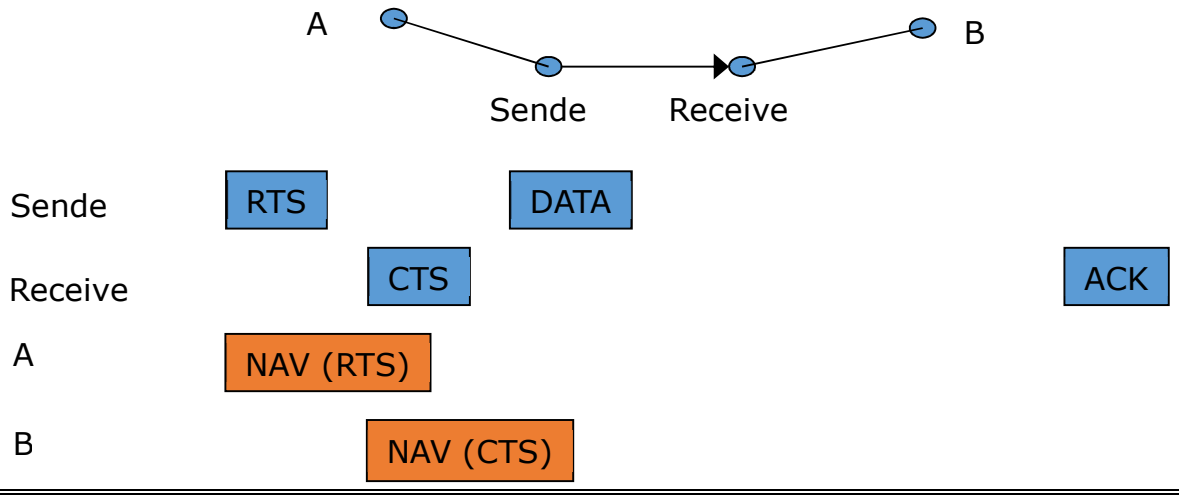


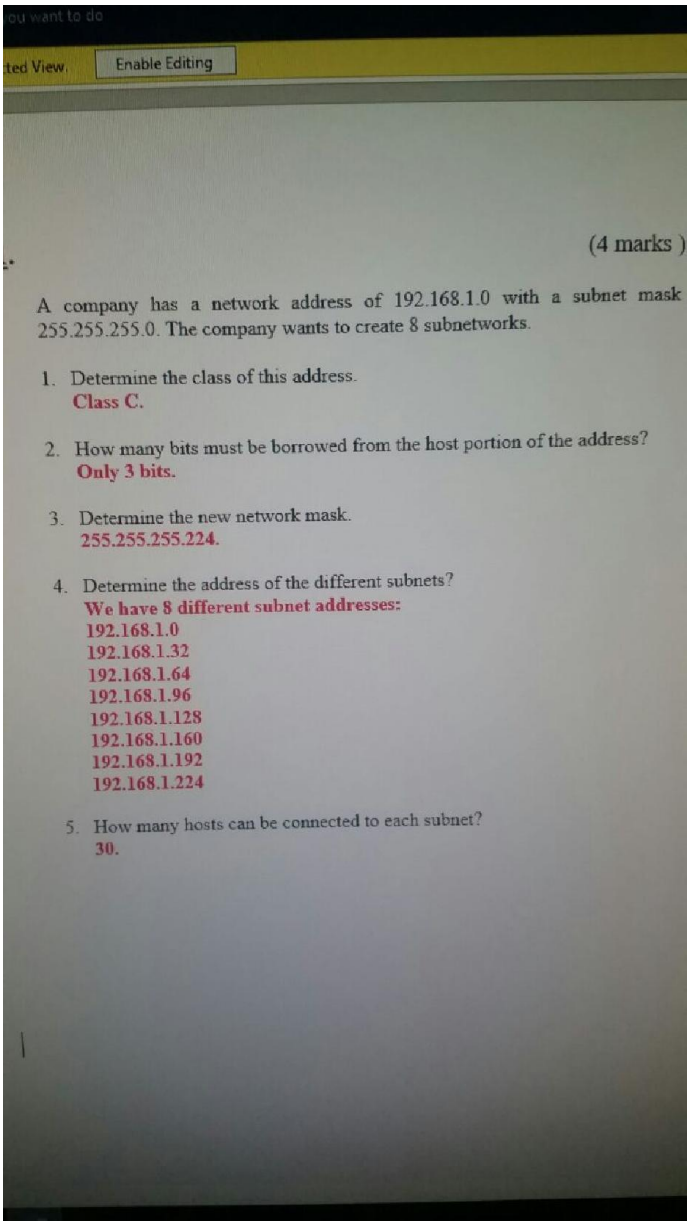
CRC→ binary division
Sender and receiver

Slotted time in Ethernet ..given 10 mb

Max & Min Ethernet frame:
Minimum: 64 bytes (512 bits)
Maximum: 1518 bytes (12,144 bits)

Explain with a diagram how the CSMA/CA uses different inter frame between the frames?





(4 marks)

A company has a network address of 192.168.1.0 with a subnet mask 255.255.255.0. The company wants to create 8 subnetworks.

1. Determine the class of this address.
   Class C.

2. How many bits must be borrowed from the host portion of the address?
   Only 3 bits.

3. Determine the new network mask.
   255.255.255.224.

4. Determine the address of the different subnets?
   We have 8 different subnet addresses:
   192.168.1.0
   192.168.1.32
   192.168.1.64
   192.168.1.96
   192.168.1.128
   192.168.1.160
   192.168.1.192
   192.168.1.224

5. How many hosts can be connected to each subnet?
   30.