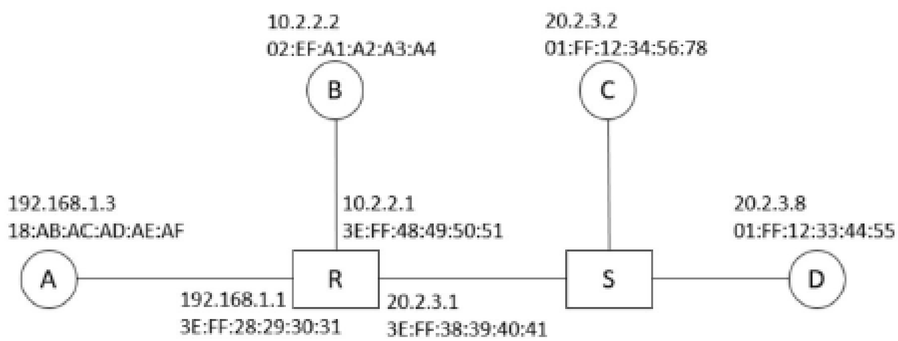
CE51, Monsoon 2020
ISE Assignment #1
Due date 20th Sept. 20@17hrs (IST)

Instructions:

- This Assignment is to be completed individually be each student.
- No partial credit for showing only final result, hence must show all necessary computational steps to gain credits

Q.1	Consider a channel with bandwidth W=1 MHz and SNR =20 dB, and we want to allocate this channel among M=10 users.	
a	What bit rate is available to each user if we divide the entire channel into M channels of equal bandwidth A: W(Width)= 1 MHz , M(Users) = 10 SNR = $10^{\frac{SNR_{db}}{10}} = 10^2$, Bandwidth per user(B) = $\frac{W}{M} = \frac{1Mhz}{10}$ = 0.1MHz To get the bit rate in this noisy channel, we use Shannon capacity BitRate(C) = B$\cdot \log_2(1 + SNR)$ = (0.1)$\cdot \log_2(1 + 100)$ = 0.66 Mbits/s	1
b	What bit rate is available to each user if the entire frequency band is used as a single channel and TDM (time division multiplexing) is applied? A: If the entire freq band is used as a single channel C = W$\cdot \log_2(1 + SNR)$ = 6.66 Mbits/s Since it's time shared, the actual bit rate available to the user is $C_{freq} = \frac{6.66}{10}$ Mbits/s = 0.66 Mbits/s	1
c	How does the comparison of (a) and (b) change if the FDM (frequency division multiplexing) scheme in (a) requires a guard band between adjacent channels? Assume the guard band is 10% of the channel bandwidth A: If only config (a) is using guard band and (b) is not, then final bit rate for (a) will be lesser than (b), since they initially had the same bitrate If the guard band is 10% of the original bandwidth distributed over the 9 spaces between bandwidth divisions, C = 0.9$\cdot C_a$ = 0.59Mbits/s	1

<table>
<tr>
<td>Q,2</td>
<td>Consider the IP network is shown below, where R is a router and S is a switch. A, B, C, and D are hosts. IP addresses and MAC addresses of hosts and router interfaces are listed as follows



</td>
<td></td>
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<tr>
<td>a</td>
<td>In this question, we assume R has a complete routing table and S has a complete forwarding table. However, R's ARP cache is empty right now.

R received a packet with the following header

<table>
<tr><td>Ethernet Src</td><td>Ethernet Dst</td><td>IP Src</td><td>IP Dest</td><td>Payload</td></tr>
<tr><td>18:AB:AC:AD:AE:AF</td><td>3E:FF:28:29:30:31</td><td>192.168.1.3</td><td>20.2.3.2</td><td></td></tr>
</table>
Since R does not have anything in its ARP cache yet, it will not be able to fill in the Ethernet Dst field before it tries to send it to next hop. Thus, R will send out an ARP request first. Which host(s) will receive this ARP request sent by R? After the device(s) received the ARP request from R, which will respond?

A:
Router has filtering capacity, so it'll broadcast the request to the NID subnet of 20.2.3.2, i.e It'll broadcast to the devices connected to the port ID 20.2.3.1, which means, that C, and D receive the broadcast ARP request from R, C's IP address would match the request, so it would respond to R's ARP.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>After the above operation was successfully completed, what would the new header of the packet that R sending out?
A:
The request from A is due, so it sends the header with A's IP, but from the MAC of R's port ID, to the IP address of C
<table>
<tr><td>Ethernet Src</td><td>Ethernet Dst</td><td>IP Src</td><td>IP Dest</td><td>Payload</td></tr>
<tr><td>3E:FF:38:39:40:41</td><td>01:FF:12:34:56:78</td><td>192.168.1.3</td><td>20.2.3.2</td><td></td></tr>
</table></td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>After the above operation was successfully completed, would R send out ARP requests again for this incoming packet?
<table>
<tr><td>Ethernet Src</td><td>Ethernet Dst</td><td>IP Src</td><td>IP Dest</td><td>Payload</td></tr>
<tr><td>18:AB:AC:AD:AE:AF</td><td>3E:FF:28:29:30:31</td><td>192.168.1.3</td><td>20.2.3.8</td><td></td></tr>
</table></td>
<td>1</td>
</tr>
</table>

A:
ARP table is now made, so R would know where to send packets, when IP of C is referenced in the request. But, it's not aware of D's MAC address, so it sends out an ARP request, to get it's MAC address registered.

Q.3 Consider a code on six-bit strings that contains (only) the following four codewords: 000000, 000011, 001111, 111111

a What is the hamming distance of this code? **1**

A:

XOR(⊕)	000000	000011	001111	111111	Min hamming distance
000000	000000	000011	001111	111111	2
000011	000011	000000	001100	111100	2
001111	001111	001100	000000	110000	2
111111	111111	111100	110000	000000	2

* So we see that the minimum distance between codewords, or the hamming distance for the codewords is 2.

b What is the rate of this code if we use it to encode two-bit strings? Is it efficient? If it is not efficient, please explain **1**

A:

* Here k=2, n=6. The rate to this codeword is k/n = $\frac{2}{6}$ = **0.333**,

We know that there are 2^{n-k} possible parity bits, that means we can distinguish atmost 2^{n-k} error conditions, hence we get $n+1 \leq 2^{n-k}$

=> $\log_2(n+1) \leq n-k$

=> $\frac{k}{n} \leq 1 - \frac{\log_2(n+1)}{n}$

In our case the ratio can be as high as $\frac{4}{6}$ = **0.532**, which means ideally for 4-bit datawords, we could use min 6-bit codewords, and detect all single bit errors, use of a longer codeword, would just reduce the efficiency, as so many parity bits won't be necessary. Here, we are using more bits than required, for dataword of length 2, as we see from the ratio, and hence it's not efficient.

c How many bit flips can be detected using this code? How many bit flips can be corrected?

A:

$d_{min} = 2 \geq s+1$,

∴ s = 1, we can detect single bit errors,

$d_{min} = 2 \geq 2t+1$,

$t \leq 0.5$ => t = 0, we can't correct any errors

d What is the max burst error that can be detected with generator $x^4 + x^3 + 1$? **1**

A :

$5 \geq j > i \geq 0$

$Burst\ error = x^j + \cdots + x^i = (x^{j-i} + \cdots + 1) \cdot x^i$

If $(x^{j-i} + \cdots + 1)$ is not divisible by $x^4 + x^3 + 1$, and if $(j-i) < 4$,

L = length of error = $j - i + 1 < 5$. But, L is an integer, hence is equal to 4

We have, Max Burst error that can be detected = 4

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Q.No	Marks	Score
1	3	
2	3	
3	4	
Total	10	