Started on	Wednesday, 13 October 2021, 2:21 PM
State	Finished
Completed on	Thursday, 14 October 2021, 6:45 PM
Time taken	1 day 4 hours
Marks	12.63/19.00
Grade	**6.65** out of 10.00 (**66**%)

Information

When working through the following quiz please keep the following points in mind:

- You are asked to implement a number of Python functions. The default language is Python3.
- Occasionally you will have to use mathematical functions from the Python 'math' package. You will need to add suitable 'import' statements to your solutions and when using such a function you will have to prefix them with the package name, e.g. to call the function 'floor' you will have to write 'math.floor' in your code.
- In many questions it is asked that you enter numerical answers in certain units. For example, we may ask you to enter your answer in milliseconds. If your answer is 0.050 seconds then you will have to enter '50', as this is the equivalent value in milliseconds.

Question **1**

Correct

Mark 1.00 out of 1.00

Suppose we are given a system with *N* stations. As per the FDMA scheme, the available channel bandwidth is sub-divided into *N* equal parts or sub-channels (we ignore the guard bands in between) and each station is allocated one of these sub-channels exclusively for its transmission. Suppose a particular station was idle for a long time and then gets handed over a packet from its higher layers for transmission. What is the access delay?

Select one:

- a. 10 seconds
- b. 1 second
- c. 1/N seconds
- d. 0 seconds ✔

Your answer is correct.

Correct

Marks for this submission: 1.00/1.00.

Question **2**

Correct

Mark 1.00 out of 1.00

Suppose we have an overall system bandwidth of *B* Hz. The bandwidth required for a guard band is *G* Hz and the bandwidth required for one user channel (sub-channel) is *U* Hz. Please find an expression for the maximum number *N* of users that can be accommodated in the system and implement it as a Python function. You will need one of the functions floor / ceil. Note that there also have to be guard bands above the user on the highest channel and below the user on the lowest channel. In other words, *N* users require *N+1* guard bands.

For example:

Test	Result
`print (number_fdma_channels(1000000, 200, 20000))`	49

Answer: (penalty regime: 10, 20, ... %)

Reset answer

```
import math
def number_fdma_channels (b_hz, g_hz, u_hz):
    """Suppose we have an overall system bandwidth of B Hz.
    The bandwidth required for a guard band is G Hz and
    the bandwidth required for one user channel (sub-channel) is U Hz"""

    N = math.floor(b_hz/(g_hz+ u_hz))

    # Also works below
    N_channel_and_guard_hz = b_hz - g_hz
    N = math.floor(N_channel_and_guard_hz/ (g_hz + u_hz))

    return N
```

	Test	Expected	Got	
✔	`print (number_fdma_channels(1000000, 200, 20000))`	49	49	✔
✔	`print (number_fdma_channels(1000000, 1000, 20000))`	47	47	✔

Passed all tests! ✔

Correct

Marks for this submission: 1.00/1.00.

Question **3**

Correct

Mark 1.00 out of 1.00

Evaluate your expression for the number of FDMA channels assuming *B* = 1 MHz, *G* = 1 kHz, U = 30 kHz.

Answer: 32 ✔

Correct

Marks for this submission: 1.00/1.00.

Question **4**

Correct

Mark 0.90 out of 1.00

Suppose we are operating with TDMA using a superframe length of *S* seconds, a guard time of *G* seconds, and the length of a user slot is *U* seconds. Please find an expression for the maximum number of users that the system can support and implement it as a Python function. You will need one of the functions ceil/floor.

For example:

Test	Result
`print (number_tdma_users(1, 0.001, 0.008))`	`111`

Answer: (penalty regime: 10, 20, ... %)

Reset answer

```
import math
def number_tdma_users (s_s, g_s, u_s):
    """Suppose we are operating with TDMA using a superframe length of S seconds,
    a guard time of G seconds, and
    the length of a user slot is U seconds."""

    N = math.floor(s_s/(g_s + u_s))

    # Doesnt works below as superframe = s_s
    # N_channel_and_guard_s = s_s - g_s
    # N = math.floor(N_channel_and_guard_s/ (g_s + u_s))
    # N += 1

    return N
```

	Test	Expected	Got	
✔	`print (number_tdma_users(1, 0.001, 0.008))`	`111`	`111`	✔
✔	`print (number_tdma_users(1.2, 0.002, 0.02))`	`54`	`54`	✔

Passed all tests! ✔

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.90/1.00**.

Question **5**

Correct

Mark 0.67 out of 1.00

Evaluate your expression for *S* = 100 ms, *G* = 1 ms, *U* = 5 ms.

Answer: 16 ✔

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.67/1.00**.

Question **6**

Correct

Mark 0.00 out of 1.00

Assume again TDMA with a superframe length S = 100 ms, guard time G = 1 ms, and length of user slot U = 5 ms. What is the average access delay of a particular user, when this user has been idle for a long time before and a new packet arrives to this user from its higher layers at a random time? Please give the value in milliseconds.

Answer: 50 ✔

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Information

For the questions in this unit please review discrete random variables, in particular the two different types of geometric random variables:

- In the first type we consider a series of repeated and independent Bernoulli trials, where each trial has success probability p, and a geometric random variable of the first kind counts the number of failed experiments before the first success. The probability mass function for the first formulation is $p(k) = p(1-p)^k$, for k in $\{0, 1, 2, 3, ...\}$, and the expectation is q/p, where $q=1-p$.
- In the second type we count the number of trials we have to make until we see the success (so the success has to be counted as well). The probability mass function is $p(k)=p*(1-p)^{(k-1)}$ for k in $\{1, 2, 3, ...\}$, and the expectation is $1/p$.

Question **7**

Correct

Mark 0.33 out of 1.00

Assume Pure ALOHA. Suppose all packets have a length of 1ms. How long is the vulnerable period of one packet? Please give the value in milliseconds.

Answer: 2 ✔

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question **8**

Correct

Mark 1.00 out of 1.00

Assume Pure ALOHA. What is the access delay for a packet arriving to a station that is idle? Please give the value in milliseconds.

Answer: 0 ✔

0, as station transmits immediately without carrier-sensing

Correct

Marks for this submission: 1.00/1.00.

Question **9**

Correct

Mark 0.33 out of 1.00

Suppose the probability that a packet collides is 20% and that successive trials are statistically independent of each other and all collide with the same probability. How many trials will a station need on average until the receiver has successfully received the packet? Please give the answer with two digits after the decimal point, no rounding.

Answer: 1.25 ✔

Success probability of one packet is $p = 0.8$. We use a geometric distribution of the second kind, which has average $1/p$. So here we use 1.25 trials on average.

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.33/1.00**.

Question **10**

Correct

Mark 1.00 out of 1.00

Consider one-persistent CSMA. Suppose the medium is idle and a station (which has previously been idle) gets a new packet. What is the access delay?

Select one:

- a. The time required to do carrier-sensing
- b. One time slot
- c. 0 ✔
- d. Three time slots

Your answer is correct.

Correct

Marks for this submission: 1.00/1.00.

Question **11**

Correct

Mark 1.00 out of 1.00

Consider one-persistent CSMA. There are two contending stations having a packet ready, and both listen on the channel for an ongoing transmission of a third station to finish. What is the probability that the two contenders will collide? Give it as a number between 0 and 1.

Answer: 1 ✔

1, as both start immediately after the previous transmission ends

Correct

Marks for this submission: 1.00/1.00.

Question **12**

Correct

Mark 0.60 out of 1.00

Consider the same setting as in the previous question, but now with *p*-persistent CSMA for some probability value $0 < p < 1$. Please find an expression for the probability that both contenders collide. Assume that they are statistically independent. You will need to:

- work out the probability that they collide in the first time slot, the probability that they collide in the second time slot, the probability that they collide in the *k*-th time slot etc.,
- combine these probabilities using the law of total probability,
- and when calculating the end result you will need the sum formula for the (infinite) geometric series.

Implement your expression as a Python function.
For example:

Test	Result
`print ("{:.3f}".format(p_persistent_csma_collision_probability(0.2)))`	`0.111`

Answer: (penalty regime: 10, 20, ... %)

Reset answer

```
def p_persistent_csma_collision_probability (p):
    return (p*p)/(1-(1-p)**2)
```

	Test	Expected	Got	
✔	`print ("{:.3f}".format(p_persistent_csma_collision_probability(0.2)))`	`0.111`	`0.111`	✔
✔	`print ("{:.3f}".format(p_persistent_csma_collision_probability(0.4)))`	`0.250`	`0.250`	✔

Passed all tests! ✔

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.60/1.00**.

Question **13**

Correct

Mark 0.90 out of 1.00

Consider *p*-persistent CSMA with a probability value *0 < p < 1*. Suppose an idle station gets a new packet to transmit, the medium is completely idle and no other station has a packet. Please find an expression for the average access delay (as a number of minislots) and implement it as a Python function.

For example:

Test	Result
`print ("{:.3f}".format(p_persistent_csma_access_delay(0.1)))`	`9.000`

Answer: (penalty regime: 10, 20, ... %)

Reset answer

```
def p_persistent_csma_access_delay (p):
    return (1-p)/p
```

	Test	Expected	Got	
✔	`print ("{:.3f}".format(p_persistent_csma_access_delay(0.1)))`	`9.000`	`9.000`	✔
✔	`print ("{:.3f}".format(p_persistent_csma_access_delay(0.4)))`	`1.500`	`1.500`	✔
✔	`print ("{:.3f}".format(p_persistent_csma_access_delay(0.6)))`	`0.667`	`0.667`	✔

Passed all tests! ✔

We need a geometric random variable of the first kind. Average access delay is *(1-p)/p*

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.90/1.00**.

Question **14**

Correct

Mark 0.00 out of 1.00

Consider the Ethernet protocol as described in the slides. What is the total overhead of the Ethernet header (including preamble) and trailer in bytes?

Answer: 26 ✔

Preamble: 7 bytes

Start-of-Frame: 1 byte

DstAddr: 6 bytes

SrcAddr: 6 bytes

Length/Type field: 2 bytes

Trailer / checksum: 4 bytes

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question **15**

Correct

Mark 1.00 out of 1.00

Ethernet: what is the minimum payload size in bytes?

Answer: 46 ✔

Correct

Marks for this submission: 1.00/1.00.

Question **16**

Correct

Mark 0.00 out of 1.00

Suppose the length/type header field carries a value of 120. What is the total length of the Ethernet packet?

Answer: 146 ✔

146 bytes. T/L field gives payload length (120 bytes) plus the 26 bytes of overhead

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

Question **17**

Correct

Mark 1.00 out of 1.00

Suppose the length/type field carries a value of 0x0800. To which higher-layer protocol does the payload belong?

Select one:

- a. TCP
- b. IPv6
- c. HTTP
- d. UDP
- e. IPv4 ✔
- f. AppleTalk
- g. IP-In-IP-encapsulation

Your answer is correct.

Correct

Marks for this submission: 1.00/1.00.

Question **18**

Correct

Mark 0.90 out of 1.00

Switched Ethernet: Suppose we have one switch with N stations attached. Each station is attached via 10 Gbps Ethernet. What is the best aggregate throughput rate in Gbps that the switch can achieve? Please implement your answer as a Python function.

Answer: (penalty regime: 10, 20, ... %)

Reset answer

```
def aggregate_throughput (n):
    return 10 * n
```

	Test	Expected	Got	
✔	`print(aggregate_throughput(10))`	100	100	✔
✔	`print(aggregate_throughput(30))`	300	300	✔

Passed all tests! ✔

N*10 Gbps, as in the ideal case all packets arriving at the same time are destined to different destinations and can be transmitted out of the switch concurrently.

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.90/1.00**.

Question **19**

Correct

Mark 0.00 out of 1.00

Ethernet MAC: Suppose a station needs to go through four backoff operations before it can start its transmission without collision. What is the average **total** number of slot times that the station waits in the backoff state?

Answer: 13 ✔

0.5 + 1.5 + 3.5 + 7.5 = 13 slot times

Correct

Marks for this submission: 1.00/1.00. Accounting for previous tries, this gives **0.00/1.00**.

◄ Quiz: Local area networks and medium access control

Jump to...

Quiz: IPv4 Networking (practice copy) ►