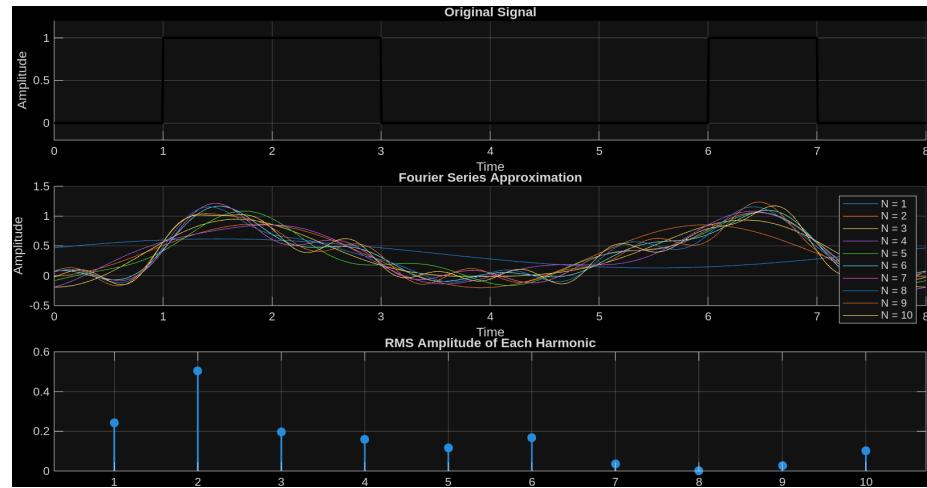


# Project 1

## q1

code can be found in Appendix 1

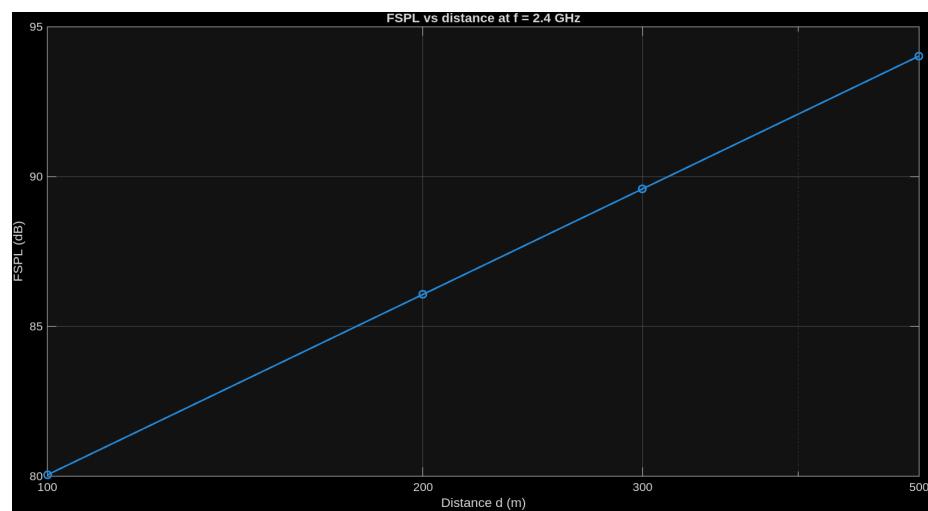


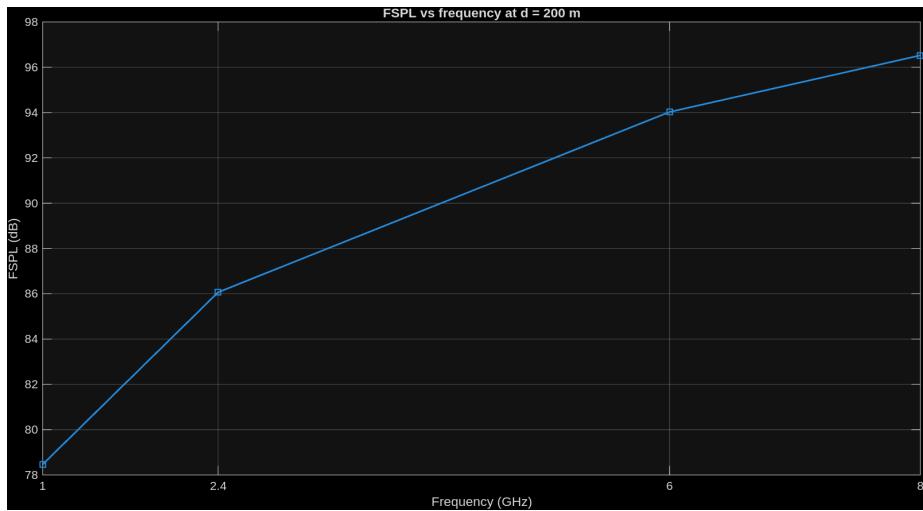
3a. i believe it may be possible to reconstruct the original signal from 10 samples, but i think for clarity more samples would be better.

## q2

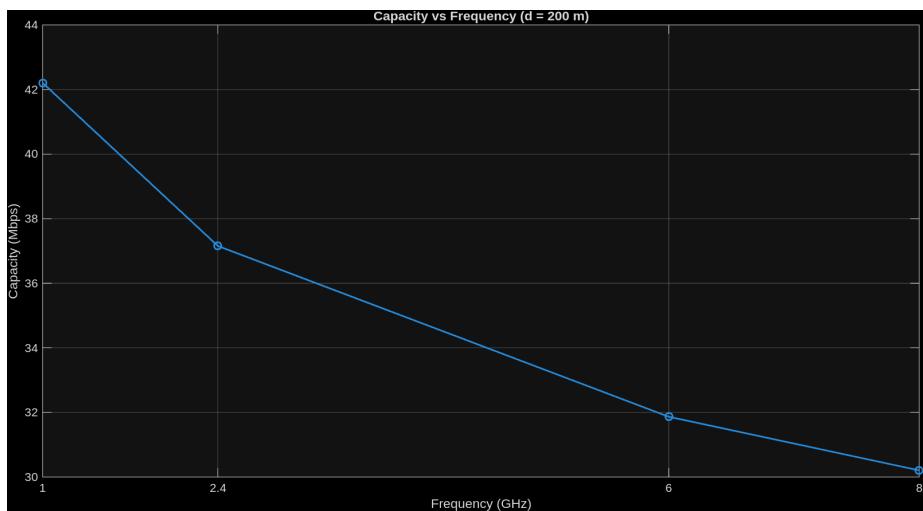
code can be found in Appendix 2

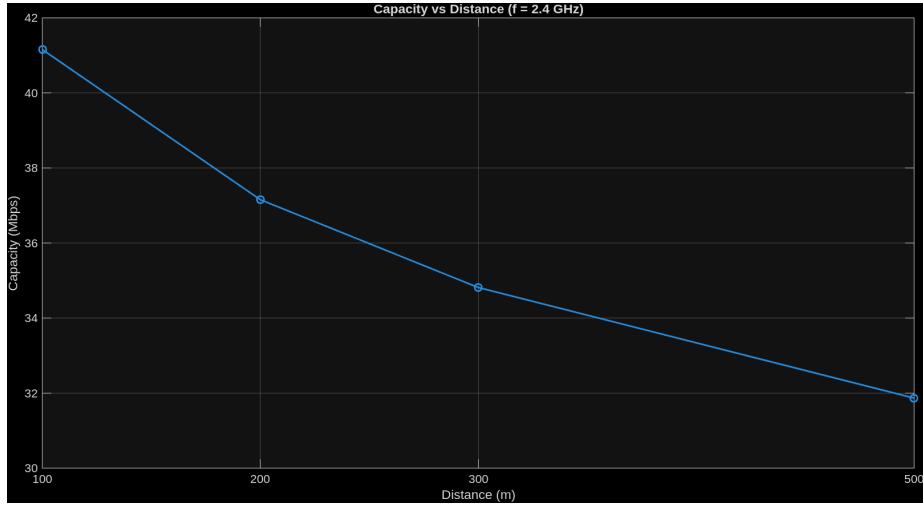
2a.





2b.





q3

0000:	08 55 31 73 ff 6f 2c 9c 58 eb a2 0f 08 00 45 00	U1s o, X.....E-
0010:	01 28 b7 cc 40 00 40 06 3e 33 ac 14 06 94 b8 33	(...@...>3....3
0020:	d8 f4 a1 14 00 50 c3 74 c5 f1 e9 e9 ca 2a 80 18	.....P.t .....*
0030:	01 f6 45 bd 00 00 01 01 08 0a 71 20 ff fe 8b 27	..E.....q ..'
0040:	2c 96 47 45 54 20 2f 20 48 54 54 50 2f 31 2e 31	, GET / HTTP/1.1
0050:	0d 0a 48 6f 73 74 3a 20 78 31 2e 69 2e 6c 65 6e	Host: x1.i.len
0060:	63 72 2e 6f 72 67 0d 0a 43 6f 6e 6e 65 63 74 69	cr.org.. Connecti
0070:	6f 6e 3a 20 6b 65 65 70 2d 61 6c 69 76 65 0d 0a	on: keep -alive..
0080:	55 73 65 72 2d 41 67 65 6e 74 3a 20 4d 6f 7a 69	User-Age nt: Mozi
0090:	6c 6c 61 2f 35 2e 30 20 28 58 31 31 3b 20 4c 69	lla/5.0 (X11; Li
00a0:	6e 75 78 20 78 38 36 5f 36 34 29 20 41 70 70 6c	nux x86_64) Appl
00b0:	65 57 65 62 4b 69 74 2f 35 33 37 2e 33 36 20 28	eWebKit/ 537.36 (
00c0:	4b 48 54 4d 4c 2c 20 6c 69 6b 65 20 47 65 63 6b	KHTML, l ike Geck
00d0:	6f 29 20 43 68 72 6f 6d 65 2f 31 34 30 2e 30 2e	o) Chrom e/140.0.
00e0:	30 2e 30 20 53 61 66 61 72 69 2f 35 33 37 2e 33	0.0 Safa ri/537.3
00f0:	36 0d 0a 41 63 63 65 70 74 2d 45 6e 63 6f 64 69	6 Accep t-Encodi
0100:	6e 67 3a 20 67 7a 69 70 2c 20 64 65 66 6c 61 74	ng: gzip , deflat
0110:	65 0d 0a 41 63 63 65 70 74 2d 4c 61 6e 67 75 61	e Accep t-Langua
0120:	67 65 3a 20 65 6e 2d 55 53 2c 65 6e 3b 71 3d 30	ge: en-U S,en;q=0
0130:	2e 39 0d 0a 0d 0a	.9.....

3a. 2c 9c 58 eb a2 0f

3b. 08 55 31 73 ff 6f it is the address of my router

3c. 80 00 IPv4

3d. byte 0042 which is 66 in decimal making it the 67th byte

0000	2c 9c 58 eb a2 0f 08 55	31 73 ff 6f 08 00 45 20	, ·X···U 1s.o..E
0010	07 18 e0 5d 40 00 34 06	1b 92 b8 33 d8 f4 ac 14	... ]@ 4 ... 3 ...
0020	06 94 00 50 a1 14 e9 e9	ca 2a c3 74 c6 e5 80 18	... P ... * t ...
0030	01 fc 4a db 00 00 01 01	08 0a 8b 27 2c ce 71 20	... J ... ', q
0040	ff fe 48 54 54 50 2f 31	2e 31 20 32 30 30 20 4f	... HTTP/1 .1 200 0
0050	4b 0d 0a 53 65 72 76 65	72 3a 20 6e 67 69 6e 78	K · Serve r: nginx
0060	0d 0a 43 6f 6e 74 65 6e	74 2d 54 79 70 65 3a 20	... Conten t-Type:
0070	61 70 70 6c 69 63 61 74	69 6f 6e 2f 70 6b 69 78	applicat ion/pkix
0080	2d 63 65 72 74 0d 0a 4c	61 73 74 2d 4d 6f 64 69	-cert · L ast-Modi
0090	66 69 65 64 3a 20 4d 6f	6e 2c 20 32 38 20 41 70	fied: Mo n, 28 Ap
00a0	72 20 32 30 32 35 20 31	39 3a 32 34 3a 31 34 20	r 2025 1 9:24:14
00b0	47 4d 54 0d 0a 45 54 61	67 3a 20 22 36 38 30 66	GMT · ETa g: "680f
00c0	64 35 64 65 2d 35 36 66	22 0d 0a 43 6f 6e 74 65	d5de-56f " · Conte
00d0	6e 74 2d 4d 69 73 70 6f	73 69 74 69 6f 6e 3a 20	nt-Dispo sition:
00e0	61 74 74 61 63 68 6d 65	6e 74 3b 20 66 69 6c 65	attachme nt; file
00f0	6e 61 6d 65 3d 22 49 53	52 47 20 52 6f 6f 74 20	name="IS RG Root
0100	58 31 2e 64 65 72 22 0d	0a 41 63 63 65 70 74 2d	X1.der" · Accep-
0110	52 61 6e 67 65 73 3a 20	62 79 74 65 73 0d 0a 56	Ranges: bytes · V
0120	61 72 79 3a 20 41 63 63	65 70 74 2d 45 6e 63 6f	ary: Acc ept-Encod
0130	64 69 6e 67 0d 0a 43 6f	6e 74 65 6e 74 2d 45 6e	ing · Co ntent-En
0140	63 6f 64 69 6e 67 3a 20	67 7a 69 70 0d 0a 43 61	coding: gzip · Ca
0150	63 68 65 2d 43 6f 6e 74	72 6f 6c 3a 20 6d 61 78	che-Cont rol: max
0160	2d 61 67 65 3d 36 39 34	36 35 0d 0a 45 78 70 69	-age=694 65 · Expi
0170	72 65 73 3a 20 53 61 74	2c 20 31 31 20 4f 63 74	res: Sat , 11 Oct
0180	20 32 30 32 35 20 30 30	3a 31 31 3a 35 33 20 47	2025 00 :11:53 G
0190	4d 54 0d 0a 44 61 74 65	3a 20 46 72 69 2c 20 31	MT · Date : Fri, 1
01a0	30 20 4f 63 74 20 32 30	32 35 20 30 34 3a 35 34	0 Oct 20 25 04:54
01b0	3a 30 38 20 47 4d 54 0d	0a 43 6f 6e 74 65 6e 74	:08 GMT · Content
01c0	2d 4c 65 6e 67 74 68 3a	20 31 33 34 31 0d 0a 43	-Length: 1341 · C
01d0	6f 6e 6e 65 63 74 69 6f	6e 3a 20 6b 65 65 70 2d	onnectio n: keep-
01e0	61 6c 69 76 65 0d 0a 0d	0a 1f 8b 08 00 00 00 00	alive · · · · · · · ·
01f0	00 00 00 33 68 62 cd 36	68 62 0e 5e c0 cc c4 c8	... 3hb · 6 hb ^ · ·
0200	c4 24 c8 d0 24 70 7e c3	25 87 c7 91 2e c9 0f 76	\$ · \$p~ % · · v
0210	27 37 75 33 18 f0 b2 71	6a b5 79 b4 7d e7 65 64	'7u3 · · q j · y } · ed
0220	e4 66 65 30 f0 37 e4 36	e0 64 63 0e 65 61 13 66	· fe0 · 7 · dc · ea · f
0230	0a 0d 36 44 34 50 07 71	b8 84 15 3c f3 4a 52 8b	· 6 · 4P · q · · < · JR ·
0240	f2 52 4b 14 82 53 93 4b	8b 32 4b 2a 15 82 52 8b	RK · S · K · 2K* · R ·
0250	53 13 8b 92 33 14 dc 8b	f2 4b 0b 0c 45 0d 84 41	S · · 3 · · K · E · A
0260	4a 99 85 79 3c 83 83 dc	15 82 f2 f3 4b 14 22 0c	J · y < · · · · K · "
0270	0d e4 c4 79 0d 4d 0d cc	0c 4c 0c 0d 0d 4c 8c 2d	· y · M · · L · · L · -
0280	a2 c4 79 8d 91 b9 d4 b7	b0 89 49 09 d9 53 8c ac	· y · · · I · S ·
0290	0c cc 4d 4c fc 0c 40 71	2e a6 26 26 46 86 b5 2f	· ML · @q · &&F · /
02a0	54 8a bf 88 98 7f 9e 3d	4f 3b 5c 43 a6 7d df 9d	T · · · = O ; \C · } ·
02b0	ed f7 2d 26 f4 e4 d9 3c	0b 5f 50 f1 bd f4 d0 a2	· · & · < _P · · ·
02c0	7f 5f b3 f2 be 31 f8 6b	dc be 97 d1 96 e3 32 79	· · 1 · k · · · · 2y
02d0	db c6 e4 bf 22 42 d9 fb	e5 2f bd 32 9c ad 58 77	· "B · / 2 · Xw
02e0	d1 d8 66 97 c7 d7 bb 95	f7 37 ef f8 2f f4 51 71	· f · · · 7 / / Qq
02f0	96 f7 c1 ae b6 c2 4c af	b4 b4 9c fe 3a 9b 82 fd	· · L · · · · :
0300	6b 35 95 d8 3e 3f 39 f0	ac 61 dd 23 ef fe ed 33	k5 · > 29 · a # · 3
0310	eb a6 30 cf bf ec 3e bd	66 a6 87 72 f0 0b 8b 75	· 0 · · > f · r · u
0320	fe 5c f9 cd 7a 17 3d c3	7b 1a 4a b6 dd d2 bf 60	· \ · z = { · J · ·
0330	d1 5b cd 5c a0 28 5d fa	c9 c0 e6 57 ff ba bb b7	· [ \ · ( ] · · W · ·
0340	92 57 bf 16 f3 3f d4 27	e8 5d 77 9e fb c5 ff ad	· W · ? ' · ]w · · ·
0350	e5 7a 5f 36 55 7b 3d f0	11 52 e5 29 e8 65 d6 5c	· z _6U { = R ) e \
0360	f0 30 58 e5 8d f0 cd 77	92 fb 05 36 7b f5 d8 77	· 0X · · w · · 6 { · w
0370	2e 4e 0c bc b7 a6 9d 7d	ca 97 e4 c2 37 7a 8f f2	· N · · · } · · 7z ·
0380	a3 67 34 3e ec 8c 31 a9	cc 29 7b 6f 3d 21 a9 f2	g4 > 1 · ) { o = ! ·
0390	d9 ed 25 b3 f4 d5 8e 5e	10 78 c8 77 ef a6 40 9f	· % · · ^ x · w · @ ·
03a0	d8 ef ed df 57 7c 3f fe	94 89 7d 46 bf 19 c7 d4	· · W   ? · } F · ·
03b0	e7 8f cc a7 f1 9a 95 ce	fb cd 57 b4 51 76 f6 1e	· · · · · W · Qv ·

03c0	e6 9f 9e ac 37 1a e1 b2	6e d1 ba e6 f8 72 0d 63	... / ... n ... r c
03d0	d9 54 2e fe 1b f7 af ee	15 92 37 d5 d7 10 cf b9	.T, ... . . . 7 ...
03e0	34 e3 e0 0a ce 94 f2 3c	77 f3 5d e7 d6 44 c6 65	4 . . . < w ] . D e
03f0	cc ad 2f ba d6 79 94 cd	51 d3 2e d2 ee ae da 57	. / . y Q . . . w
0400	95 93 82 cb a3 16 fb 38	c8 bb 2d 9c b9 75 b9 55	. . . . 8 . . . u U
0410	60 5e 9b f5 bc da a2 e5	42 ac 15 91 6f ed 02 2b	. ^ . . . B o . +
0420	44 b9 99 fb 7b 2f e8 b3	6e b2 ab f6 92 f1 2e 66	D . . { / . n . . . f
0430	15 fa 73 ec d5 83 00 e1	1a e7 c9 25 9b 4f 95 3c	. s . . . % 0 <
0440	ef 93 67 e4 b8 60 70 25	ba d0 6c 0b fb ae 83 06	. g . . p% . l . . .
0450	06 31 1e db 9b ac 67 2c	ab 4d e8 5a b4 58 b3 e9	. 1 . . g, M Z X .
0460	cc ae bd cd 2c d2 8b 9a	99 1d 17 5e 63 fd 28 7d	. . , . . . ^c . { }
0470	68 db 87 15 35 6d d6 6e	b2 3c b4 3a ee 94 cd 2a	h . . 5m n + < : . . *
0480	db 2f 9f b5 d4 56 b2 ff	b5 c5 e7 94 7b 27 b4 79	. / . V . . . { ' y
0490	b9 34 fe 7f bf fd 48 d4	e9 8a d2 05 f5 d8 87 95	. 4 . . H . . . .
04a0	ff 24 9e 17 74 ac f5 7b	76 b3 db ea d8 5d f5 c0	. \$ t . { v . . . ] .
04b0	bc ff 7b 52 be 1a 3b fb	33 31 33 32 30 2e 76 32	. { R . ; 31320.v2
04c0	70 30 e0 03 26 1f 59 7e	46 c6 ff 2c 2c c0 dc c1	p0 . & Y~ F . . . , .
04d0	66 c0 0f e2 0b 83 f8 ac	06 cc 40 ca 40 16 24 c0	f . . . . @ @ \$ .
04e0	c7 22 c6 22 52 b9 25 f2	59 f5 b6 a7 4f 18 8b 1b	. " . " R . % . Y . . 0 .
04f0	38 3a 4e 48 45 7c 7b 39	3b 0f 2d eb 30 83 12 57	8:NHE {9 ; -- 0 . W
0500	a8 7c c4 ca 3d 9b 56 04	5c e0 d9 78 43 2a 53 41	.   . = V . \ . xC*SA
0510	5d 93 63 4d 62 69 4c 57	de 8f a6 a7 99 fa 57 bf	] . cMbillW . . . . W
0520	85 79 ef dc 51 2c 10 79	59 71 7a dd 73 9f c2 df	. y . Q, y Yqz . s . .
0530	9b 2e 25 ac b5 5c 1f fd	4a 5c 31 ac f5 63 00 5f	. . % . \ . J\1 . c . -
0540	e4 eb 73 0f 22 5f ee 3a	29 fa be 6d 6e 7f 4b c3	. s " _ : ) . mn K .
0550	b7 27 2f 27 4e b8 23 3e	3b 49 da f5 43 da d4 4b	. ' / ' N . # > ; I . c . K
0560	35 f9 87 5e 59 bf 97 3f	7f fa da 3a f5 8f 2b 37	5 . ^ Y . ? . . . + 7
0570	9c 58 f7 b7 b6 6e d6 2f	25 96 d7 ff 6f d6 bf 9a	. X . . n / % . o . . .
0580	a8 ad b4 51 9c af ff 53	97 49 74 c4 8d 3f 8c 27	. . Q . . S . It . ? . '
0590	43 76 ee 50 3b d3 d5 61	dc e9 a3 db 62 d3 74 ff	cv P; . a . . . b t .
05a0	dd b4 70 d6 5d 3a bb bf	1f d9 7e dc cf ba 69 9f	. . p ] : . . . . i .
05b0	e1 09 a5 e2 e2 49 17 0f	35 2c b1 b4 14 30 56 6e	. . . . I . . 5 . . . 0Vn
05c0	f2 b1 99 df b6 29 74 86	ec 3e cd b6 1e a5 d9 f3	. . . . )t . > . . . .
05d0	1e 65 5b 87 5b 35 15 f8	de e1 3c de 79 9a 8b dd	e[ [5 . . < y . . . .
05e0	37 e7 45 6c df c9 f7 e7	56 1f df bd 55 db cf f5	7 . El . . . V . . . U .
05f0	9a d7 05 b5 33 4f 8b 4e	71 64 2d 9d fa 58 74 e1	. . . . 30 N qd . Xt .
0600	f7 25 6f 4f ea c4 2f fd	fd 7f 8d 06 93 de be eb	. %o0 . / . . . . .
0610	d5 bb 1f 17 56 4f 10 bb	cc 1e e7 16 5c 63 ce ee	. . . . V O . . . . \c .
0620	d4 73 f9 c8 b4 39 57 67	6e d5 7a 30 55 aa c1 63	. s . . 9Wg n z0U . c .
0630	9d 8f 25 fb b9 33 ee 4b	82 a6 6a ef da f1 7b ed	. . % . 3 K . j . . { .
0640	25 e3 e0 da a7 b2 be b9	57 17 6e 3c ee 94 ff cc	% . . . . W n < . . . .
0650	41 dd 34 66 b1 c6 76 f6	de e7 bd c6 13 9e 2b cf	A . 4f . v . . . . + .
0660	ff 1d 30 a7 32 c7 ed ea	16 d1 cd d3 f2 ea 66 f3	. . 0 2 . . . . f . . .
0670	4c b3 da 11 a4 6b 7f 2d	fa e1 6f 8e 43 2d ff 54	L . . . k . . . o C . T
0680	56 2c ee bc b5 26 eb a1	84 d6 c6 15 ce 89 d1 97	V, . . . & . . . . .
0690	e5 ef 58 f7 96 7d d2 7d	d1 5b 7a 5f dc 38 c7 36	. . X . } . } . [ z_ 8 . 6
06a0	f8 77 f5 69 c7 f8 ff 77	16 5d 48 b4 78 38 6d c7	. . w i . . w . ] H . x8m .
06b0	9a d8 6e f3 eb a5 57 8d	0f cc 14 5c 37 d7 f1 60	. . n . . W . . . \7 . `
06c0	51 69 cb 3e 26 47 a7 f8	74 15 8f 29 17 67 ab ef	Qi > & G . t . . ) g .
06d0	63 b7 df b9 c3 bf b1 24	f0 61 d5 f6 b7 73 95 1f	c . . . . \$ . a . . s .
06e0	ed 7b 70 55 83 45 d8 c6	90 79 de dd aa 9c fe 63	. { pU E . . y . . . c
06f0	ec 12 c7 ea ef b9 f7 d9	6b cc 63 61 3b bf 34 c4	. . . . . k . ca; 4 .
0700	a4 7c ef 9b ce d9 2f c5	9d ef 47 df 8e ff d7 27	.   . . . / . . G . . . '
0710	17 be e8 ac c3 dc ba 24	a5 5b f7 24 d4 01 b2 a5	. . . . . \$ . [ \$ . . .
0720	e5 65 6f 05 00 00		eo . . . . .

3e. 08 55 31 73 ff 6f this is the same address as the destination of the last packet, it is my router

3f. 2c 9c 58 eb a2 0f yes it is

3g 08 00 IPV4

3h. it is also byte 0042, therefor it is also the 67th byte

q4

```
carter@carter:~$ arp
Address          HWtype  HWaddress          Flags Mask      Iface
172.20.2.148      (incomplete)
172.20.10.199     (incomplete)
_gateway          ether    08:55:31:73:ff:6f  C
172.20.0.141      (incomplete)
172.20.12.87      (incomplete)
172.20.3.228      (incomplete)
172.20.7.252      (incomplete)
172.20.8.187      (incomplete)
172.20.13.214     (incomplete)
carter@carter:~$ |
```

4a. the address is the ip address, HWtype is the type of connection, HW address is the mac address, Flags indicate if the mac address is complete or not, and whether it was manually set or not, iface is the interface that each address is connecting through

```
ff ff ff ff ff ff 2c 9c 58 eb a2 0f 08 06 00 01
08 00 06 04 00 01 2c 9c 58 eb a2 0f ac 14 06 94
00 00 00 00 00 00 ac 14 0d d6
```

```
carter@carter:~$ arp
Address          HWtype  HWaddress          Flags Mask      Iface
172.20.2.148      (incomplete)
172.20.10.199     (incomplete)
_gateway          ether    08:55:31:73:ff:6f  C
172.20.0.141      (incomplete)
172.20.12.87      (incomplete)
172.20.3.228      (incomplete)
172.20.7.252      (incomplete)
172.20.8.187      (incomplete)
172.20.13.214     (incomplete)
carter@carter:~$ |
```

4b. Source: 2c 9c 58 eb a2 0f Destination: ff ff ff ff ff

4c. 0806 ARP

4d. i. 14 bytes ii. 00 01 request iii. yes iv. at the very end of the packet

4e. i. 14 again ii. 00 02 reply iii. right before the target ip address

4f. (i didnt get a response from the device i pinged, but i did get a response from a different device so i will use that instead)

source: (2c:9c:58:eb:a2:0f) Destination: (08:55:31:73:ff:6f)

## APPENDIX

```
1

clear;
clc;
close all;

T=8;
f = 1/T;
t = linspace(0, T, 1000);

bits = [0 1 1 0 0 0 1 0];
signal = zeros(size(t));

for k = 1:8
    signal(t >= (k-1) & t<k) = bits(k);
end

figure;
subplot(3,1,1);
hold on;
plot(t, signal, 'k', 'LineWidth', 2);
ylim([-0.2 1.2]);
title('Original Signal');
xlabel('Time');
ylabel('Amplitude');
grid on;

c = 3/4;
N_Values = 1:10;
colors = lines(length(N_Values));

subplot(3,1,2);
hold on;

for N = N_Values
    g = 0.5*c;
    for n = 1:N
        an = (1/(pi*n))*(cos((pi*n)/4)-cos((3*pi*n)/4)+cos((6*pi*n)/4)-cos((7*pi*n)/4));
        bn = (1/(pi*n))*(sin((3*pi*n)/4)-sin((pi*n)/4)+sin((7*pi*n)/4)-sin((6*pi*n)/4));

        g = g + an * sin(2*pi*N*f*t) + bn * cos(2*pi*n*f*t);
    end
end
```

```

    end

    plot(t, g, 'Color', colors(N,:), 'DisplayName', sprintf('N = %d', N));
end

title('Fourier Series Approximation');
xlabel('Time');
ylabel('Amplitude');
legend show;
grid on;

a_vals = zeros(1,10);
b_vals = zeros(1,10);
rms_vals = zeros(1,10);

for n = 1:10
    a_vals(n) = (1/(pi*n))*(cos((pi*n)/4)-cos((3*pi*n)/4)+cos((6*pi*n)/4)-cos((7*pi*n)/4));
    b_vals(n) = (1/(pi*n))*(sin((3*pi*n)/4)-sin((pi*n)/4)+sin((7*pi*n)/4)-sin((6*pi*n)/4));
    rms_vals(n) = sqrt(a_vals(n)^2 + b_vals(n)^2);
end

subplot(3,1,3);
stem(1:10, rms_vals, 'filled', 'LineWidth', 1.5);
title('RMS Amplitude of Each Harmonic');
grid on;

2

clear; close all; clc;

c = 3e8;
Pt_dbm = 30;
Gt = 3;
Gr = 1;
L_tx = 1;
L_rx = 2;
NO_dbmHz = -174;
B = 2e6;

% 2a
f_24 = 2.4e9;
d_list = [100, 200, 300, 500];

fspl = @(d,f) 20*log10(4*pi.*d.*f./c);

```

```

FSPL_d = fspl(d_list, f_24);

figure;
semilogx(d_list, FSPL_d, '-o', 'LineWidth', 1.4);
grid on;
xlabel('Distance d (m)'); ylabel('FSPL (dB)');
title('FSPL vs distance at f = 2.4 GHz');
xticks(d_list);

d_fixed = 200;
f_list = [1e9, 2.4e9, 6e9, 8e9];
FSPL_f = fspl(d_fixed, f_list);

figure;
plot(f_list/1e9, FSPL_f, '-s', 'LineWidth', 1.4);
grid on;
xlabel('Frequency (GHz)'); ylabel('FSPL (dB)');
title('FSPL vs frequency at d = 200 m');
xticks(f_list/1e9);

% 2b
recv_power_dbm = @(d,f) Pt_dbm + Gt - L_tx - fspl(d,f) + Gr - L_rx;

N_dbm = NO_dbmHz + 10*log10(B);

% i)
Pr_i = arrayfun(@(f) recv_power_dbm(d_fixed,f), f_list);
SNR_db_i = Pr_i - N_dbm;
SNR_lin_i = 10.^{SNR_db_i/10};
Capacity_i = B .* log2(1 + SNR_lin_i);

% ii)
Pr_ii = arrayfun(@(d) recv_power_dbm(d,f_24), d_list);
SNR_db_ii = Pr_ii - N_dbm;
SNR_lin_ii = 10.^{SNR_db_ii/10};
Capacity_ii = B .* log2(1 + SNR_lin_ii);

fprintf('\nCase (i)\n');
for i=1:length(f_list)
    fprintf(' f=%1f GHz: Pr = %.3f dBm, SNR = %.3f dB, Capacity = %.3f Mbps\n', ...
        f_list(i)/1e9, Pr_i(i), SNR_db_i(i), Capacity_i(i)/1e6);
end

fprintf('\nCase (ii)\n');
for i=1:length(d_list)
    fprintf(' d=%d m: Pr = %.3f dBm, SNR = %.3f dB, Capacity = %.3f Mbps\n', ...

```

```

d_list(i), Pr_ii(i), SNR_db_ii(i), Capacity_ii(i)/1e6);
end

figure;
plot(f_list/1e9, Capacity_i/1e6, '-o', 'LineWidth', 1.4);
grid on;
xlabel('Frequency (GHz)'); ylabel('Capacity (Mbps)');
title('Capacity vs Frequency (d = 200 m)');
xticks(f_list/1e9);

figure;
plot(d_list, Capacity_ii/1e6, '-o', 'LineWidth', 1.4);
grid on;
xlabel('Distance (m)'); ylabel('Capacity (Mbps)');
title('Capacity vs Distance (f = 2.4 GHz)');
xticks(d_list);

```