COMP 389
Programming Project 1

Programming & Good Habbits

Always **check return code!**

- `open(), write()`
- `malloc()`
- `switch (errno) { ... }`

Initialize *all* variables!

```
int i=0;
struct timeval timeout;
memset(&timeout, 0, sizeof(struct timeval));
```

Never **leak any resources!**

- `malloc() and free()`
- `open() and close()`
- **Delete temporary files**

Programming & Good Habbits (Cont...)

Don't **assume external input will be short**

- **use `strncpy()` and not `strcpy()`**
- **use `snprintf()` and not `sprintf()`**
- **use `sizeof()` and not a constant, for example,**

```
unsigned char buf[80];

buf[0] = '\0'; /* initialization */
strncpy(buf, sizeof(buf), *argv[1]);
buf[sizeof(buf)-1] = '\0'; /* in case *argv[1] is long */
```

Fix your code so that you have *zero* compiler warnings!

General Requirements

Some major requirements for both programming assignments

- **severe pentalty for failing `make`**
- **severe pentalty for using large memory buffers**
- **severe pentalty for any segmentation fault -- you must test your code well**
- **if input file is large, you must not read the whole file into into a large memory buffer**
  - **must learn how to read a large file properly**
- **severe pentalty for not using separate compilation or for having all your source code in header files -- you must learn to plan how to write your program**

Grading Requirements

- It's important that every byte of your data is read and written correctly.
- Run your code against the *grading guidelines*
  - must not change the commands there
    - might change the data for actual grading, but will stick to the commands
  - to be fair to all, running scripts in the grading guidelines is *the only way to grade*

Separate Compilation

- Break up your code into *modules*
  - *compile the modules separately*, at least one rule per module per rule in the `Makefile`
  - a separate rule to *link* all the modules together
    - if your program requites additional libraries, add them to the link stage

- To receive full credit for separate compilation
  - to create an executable, at a minimum, you must run the compiler at least *twice* and the linker *once*

Numbers

’Z’ is 0x5a (hex)

integer: 90

hex: 0x5a

binary: 0101 1010

octal: 0132

hexstring representation: "5a"

Memory

char buf[40]

hexstring: e7c16723f8e70c751ddd01c51d7c27d

buf[0] = 0xe7

buf[1] = 0xc1

buf[2] = 0x67

...

buf[15] = 0x7d

Hexdump

```
000000: 59 65 73 74 65 72 64 61  79 2c 0a 41 6c 6c 20 6d  Yesterday,.All m
000010: 79 20 74 72 6f 75 62 6c  65 73 20 73 65 65 6d 65  y troubles seeme
000020: 64 20 73 6f 20 66 61 72  20 61 77 61 79 0a 4e 6f  d so far away.No
000030: 77 20 69 74 20 6c 6f 6f  6b 73 20 61 73 20 74 68  w it looks as th
000040: 6f 75 67 68 0a 54 68 65  79 27 72 65 20 68 65 72  ough.They're her
000050: 65 20 74 6f 20 73 74 61  79 0a 4f 68 2c 20 49 20  e to stay.Oh, I
000060: 62 65 6c 69 65 76 65 0a  49 6e 20 79 65 73 74 65  believe.In yeste
000070: 72 64 61 79 2e 0a 0a 53  75 64 64 65 6e 6c 79 2c  rday...Suddenly,
000080: 0a 49 27 6d 20 6e 6f 74  20 68 61 6c 66 20 74 68  .I'm not half th
000090: 65 20 6d 61 6e 20 49 20  75 73 65 64 20 74 6f 20  e man I used to
0000a0: 62 65 0a 54 68 65 72 65  27 73 20 61 20 73 68 61  be.There's a sha
0000b0: 64 6f 77 20 68 61 6e 67  69 6e 67 20 6f 76 65 72  dow hanging over
0000c0: 20 6d 65 2e 0a 4f 68 2c  20 79 65 73 74 65 72 64  me..Oh, yesterd
0000d0: 61 79 0a 43 61 6d 65 20  73 75 64 64 65 6e 6c 79  ay.Came suddenly
0000e0: 2e 0a 0a 57 68 79 20 73  68 65 20 68 61 64 20 74  ...Why she had t
0000f0: 6f 20 67 6f 2c 20 49 20  64 6f 6e 74 20 6b 6e 6f  o go, I dont kno
000100: 77 0a 53 68 65 20 77 6f  75 6c 64 6e 27 74 20 73  w.She wouldn't s
000110: 61 79 2e 0a 49 20 73 61  69 64 20 73 6f 6d 65 74  ay..I said somet
000120: 68 69 6e 67 20 77 72 6f  6e 67 2c 20 6e 6f 77 20  hing wrong, now
000130: 49 20 6c 6f 6e 67 0a 46  6f 72 20 79 65 73 74 65  I long.For yeste
000140: 72 64 61 79 0a 0a 59 65  73 74 65 72 64 61 79 2c  rday..Yesterday,
000150: 0a 4c 6f 76 65 20 77 61  73 20 73 75 63 68 20 61  .Love was such a
000160: 6e 20 65 61 73 79 20 67  61 6d 65 20 74 6f 20 70  n easy game to p
000170: 6c 61 79 0a 4e 6f 77 20  49 20 6e 65 65 64 20 61  lay.Now I need a
000180: 20 70 6c 61 63 65 20 74  6f 20 68 69 64 65 20 61   place to hide a
000190: 77 61 79 0a 4f 68 2c 20  49 20 62 65 6c 69 76 65  way.Oh, I belive
0001a0: 0a 49 6e 20 79 65 73 74  65 72 64 61 79 2e 20 0a  .In yesterday. .
0001b0: 0a 2d 2d 0a 0a 62 79 20  4a 6f 68 6e 20 4c 65 6e  .--..by John Len
0001c0: 6e 6f 6e 20 61 6e 64 20  50 61 75 6c 20 4d 63 43  non and Paul McC
0001d0: 61 72 74 6e 65 79 0a --  -- -- -- -- -- -- -- --  artney.
```

Hexdump (Cont...)

Binary file (430 bytes):

```
000000: 47 49 46 38 39 61 6e 00  34 00 b3 00 00 00 00 00  GIF89an.4.~.....
000010: ff ff ff 3c 59 77 13 1a  21 b8 b8 b8 b7 b7 b7 5a  ~~~<Yw..!~~~~~~Z
000020: 5a 5a 73 73 73 72 72 72  40 40 40 00 00 00 00 00  ZZsssrrr@@@.....
000030: 00 00 00 00 00 00 00 00  00 00 00 00 00 21 f9 04  .............!~.
000040: 00 00 00 00 00 2c 00 00  00 00 6e 00 34 00 00 04  .....,....n.4...
000050: ff 50 c8 49 ab bd 38 eb  cd bb af 43 28 8e 64 69  ~P~I~~8~~~~C(~di
000060: 9e 68 aa ae 6c 4b 02 70  2c cf 74 6d df 78 ae ef  ~h~~lK.p,~tm~x~~
000070: 7c ef ff c0 a0 70 48 2c  1a 8f c8 a4 72 c9 6c 3a  |~~~~pH,.~~~r~l:
000080: 9f d0 a8 74 4a ad 5a af  d8 ac f6 57 08 78 bf 60  ~~~tJ~Z~~~~W.x~`
000090: 70 01 d0 0d 9b c3 84 c3  8c 70 06 ab 69 87 b6 18  p.~.~~~~~p.~i~~.
0000a0: ca 96 83 09 80 ba fd fc  86 e9 db 78 34 65 76 81  ~~~.~~~~~~~x4ev~
0000b0: 5b 86 87 88 89 3f 7f 76  63 83 7b 67 63 79 90 7d  [~~~~?.vc~{gcy~}
0000c0: 30 71 90 85 4d 8c 72 63  9b 90 5f 81 9e 61 92 31  0q~~M~rc~~ _~~a~1
0000d0: 8f 72 99 8a a9 aa ab 89  67 38 8c 33 a6 01 08 33  ~r~~~~~~g8~3~..3
0000e0: 76 7d 97 6d a4 56 ae 37  a6 6b 66 34 84 31 a2 5e  v}~m~V~7~kf4~1~^
0000f0: a8 ac c7 c8 c9 52 bc 36  c4 cc 32 7b 78 b2 a3 59  ~~~~~R~6~~2{x~~Y
000100: cf 82 9f c5 35 7c 6e 61  b8 a0 ca e0 e1 e2 47 d6  ~~~~5|na~~~~~~G~
000110: bf d8 ba 31 66 d2 80 00  66 e8 54 e5 32 ce c0 c1  ~~~1f~~.f~T~2~~~
000120: d4 ed bc ea e3 fa fb fc  37 f1 a5 61 cc 81 a9 77  ~~~~~~~~7~~a~~~w
000130: c7 0f 9a 74 07 b1 fc 83  e1 4b 86 ac 4a f7 0a 02  ~.~t.~~~~K~~J~..
000140: f0 16 a0 8f bb 7e 18 33  2e 31 c0 f1 c8 b4 33 78  ~.~~~~.3.1~~~~3x
000150: 5b e6 ed 61 78 6a d8 37  84 b9 66 18 88 b1 b2 88  [~~axj~7~~f.~~~~
000160: c8 6c 2f d9 4d 4a 69 e9  4b a5 46 32 56 1a 48 a0  ~l/~MJi~K~F2V.H~
000170: 53 23 14 9d 2d 5b fa 6c  d2 b3 27 91 98 9d b0 99  S#.~-[~l~~'~~~~~
000180: e9 43 4c 17 1b 54 38 73  b2 34 f2 f1 62 cc 3b 95  ~CL..T8s~4~~b~;~
000190: aa 42 25 18 89 06 47 a1  43 c3 8a 1d 4b b6 ac d9  ~B%.~.G~C~~.K~~~
0001a0: b3 68 d3 aa 5d cb b6 ad  db 2d 11 00 00 3b -- --  ~h~~]~~~~-...;
```

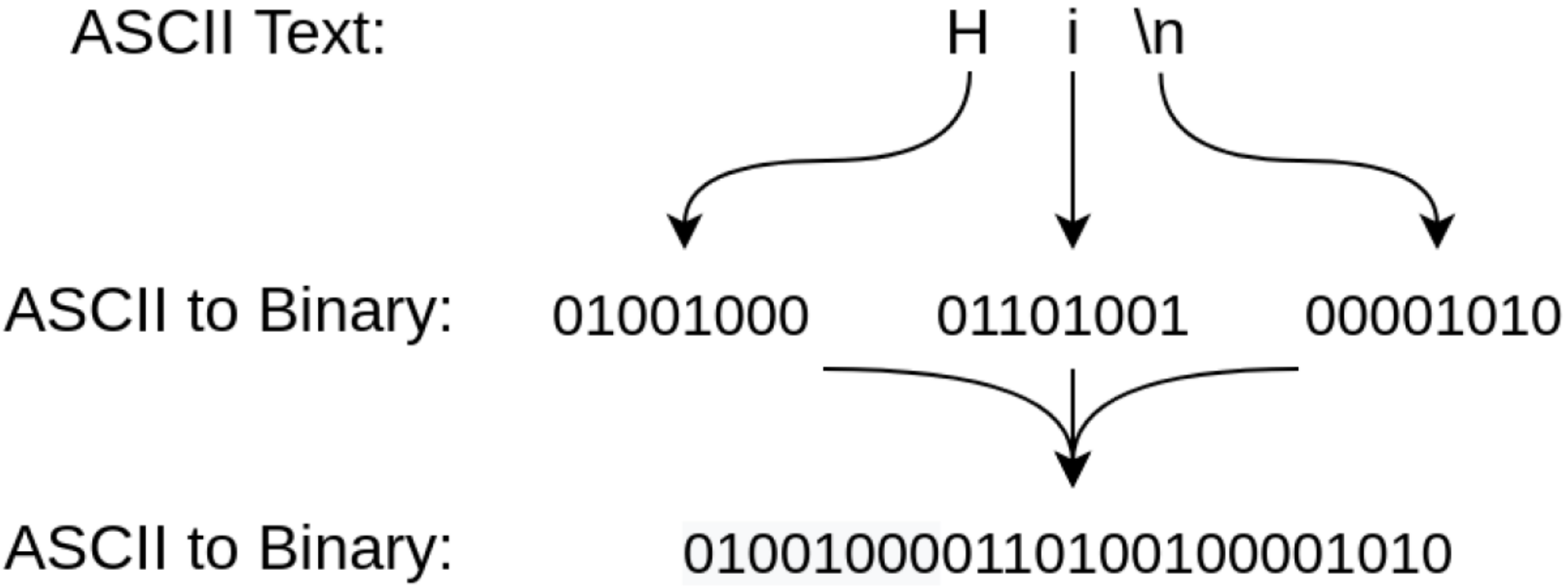
ASCII TABLE

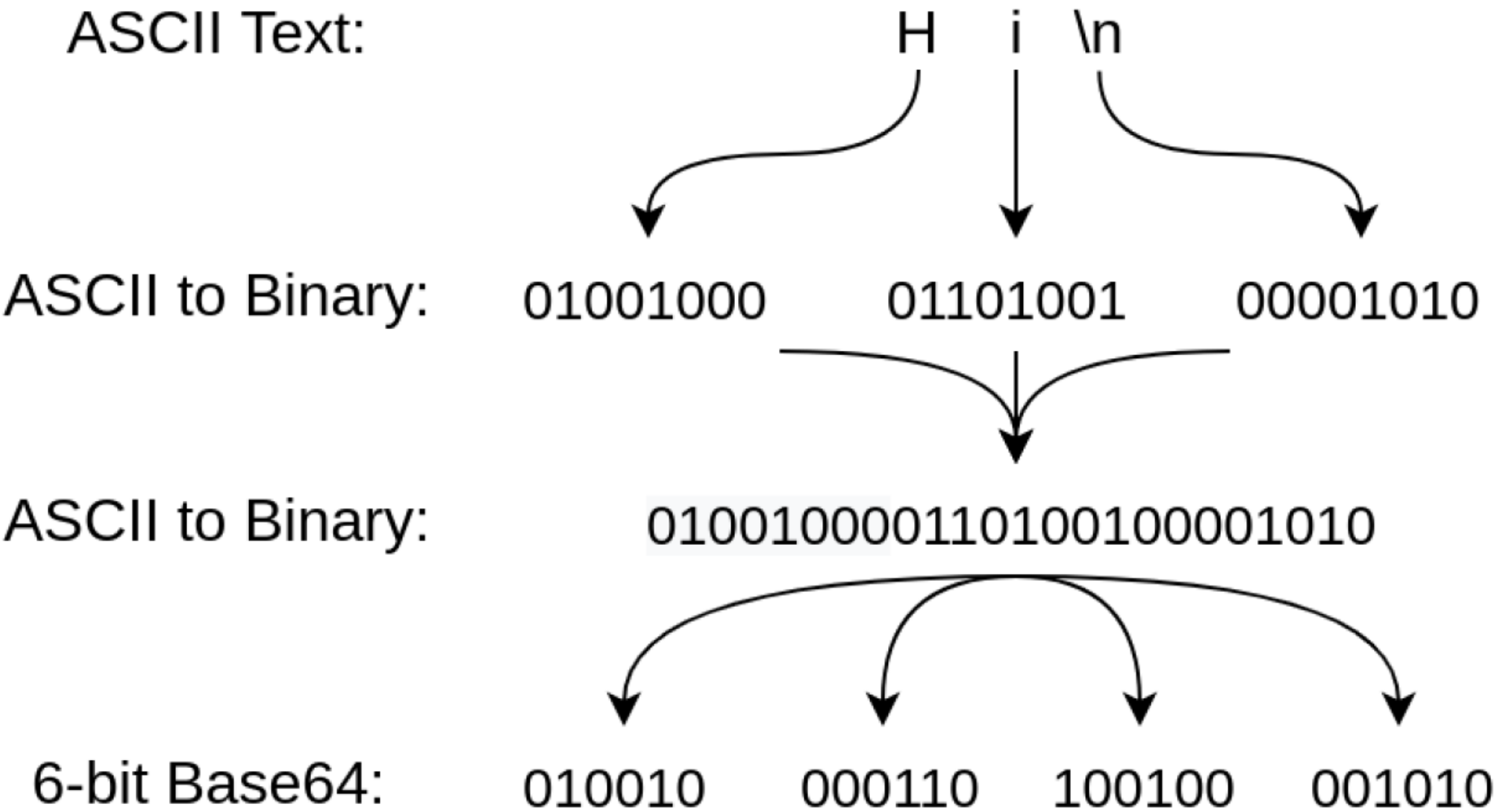
Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char	Decimal	Hex	Char
0	0	*[NULL]*	32	20	*[SPACE]*	64	40	@	96	60	`
1	1	*[START OF HEADING]*	33	21	!	65	41	A	97	61	a
2	2	*[START OF TEXT]*	34	22	"	66	42	B	98	62	b
3	3	*[END OF TEXT]*	35	23	#	67	43	C	99	63	c
4	4	*[END OF TRANSMISSION]*	36	24	$	68	44	D	100	64	d
5	5	*[ENQUIRY]*	37	25	%	69	45	E	101	65	e
6	6	*[ACKNOWLEDGE]*	38	26	&	70	46	F	102	66	f
7	7	*[BELL]*	39	27	'	71	47	G	103	67	g
8	8	*[BACKSPACE]*	40	28	(	72	48	H	104	68	h
9	9	*[HORIZONTAL TAB]*	41	29	)	73	49	I	105	69	i
10	A	*[LINE FEED]*	42	2A	*	74	4A	J	106	6A	j
11	B	*[VERTICAL TAB]*	43	2B	+	75	4B	K	107	6B	k
12	C	*[FORM FEED]*	44	2C	,	76	4C	L	108	6C	l
13	D	*[CARRIAGE RETURN]*	45	2D	-	77	4D	M	109	6D	m
14	E	*[SHIFT OUT]*	46	2E	.	78	4E	N	110	6E	n
15	F	*[SHIFT IN]*	47	2F	/	79	4F	O	111	6F	o
16	10	*[DATA LINK ESCAPE]*	48	30	0	80	50	P	112	70	p
17	11	*[DEVICE CONTROL 1]*	49	31	1	81	51	Q	113	71	q
18	12	*[DEVICE CONTROL 2]*	50	32	2	82	52	R	114	72	r
19	13	*[DEVICE CONTROL 3]*	51	33	3	83	53	S	115	73	s
20	14	*[DEVICE CONTROL 4]*	52	34	4	84	54	T	116	74	t
21	15	*[NEGATIVE ACKNOWLEDGE]*	53	35	5	85	55	U	117	75	u
22	16	*[SYNCHRONOUS IDLE]*	54	36	6	86	56	V	118	76	v
23	17	*[END OF TRANS. BLOCK]*	55	37	7	87	57	W	119	77	w
24	18	*[CANCEL]*	56	38	8	88	58	X	120	78	x
25	19	*[END OF MEDIUM]*	57	39	9	89	59	Y	121	79	y
26	1A	*[SUBSTITUTE]*	58	3A	:	90	5A	Z	122	7A	z
27	1B	*[ESCAPE]*	59	3B	;	91	5B	[	123	7B	{
28	1C	*[FILE SEPARATOR]*	60	3C	<	92	5C	\	124	7C	|
29	1D	*[GROUP SEPARATOR]*	61	3D	=	93	5D	]	125	7D	}
30	1E	*[RECORD SEPARATOR]*	62	3E	>	94	5E	^	126	7E	~
31	1F	*[UNIT SEPARATOR]*	63	3F	?	95	5F	_	127	7F	*[DEL]*

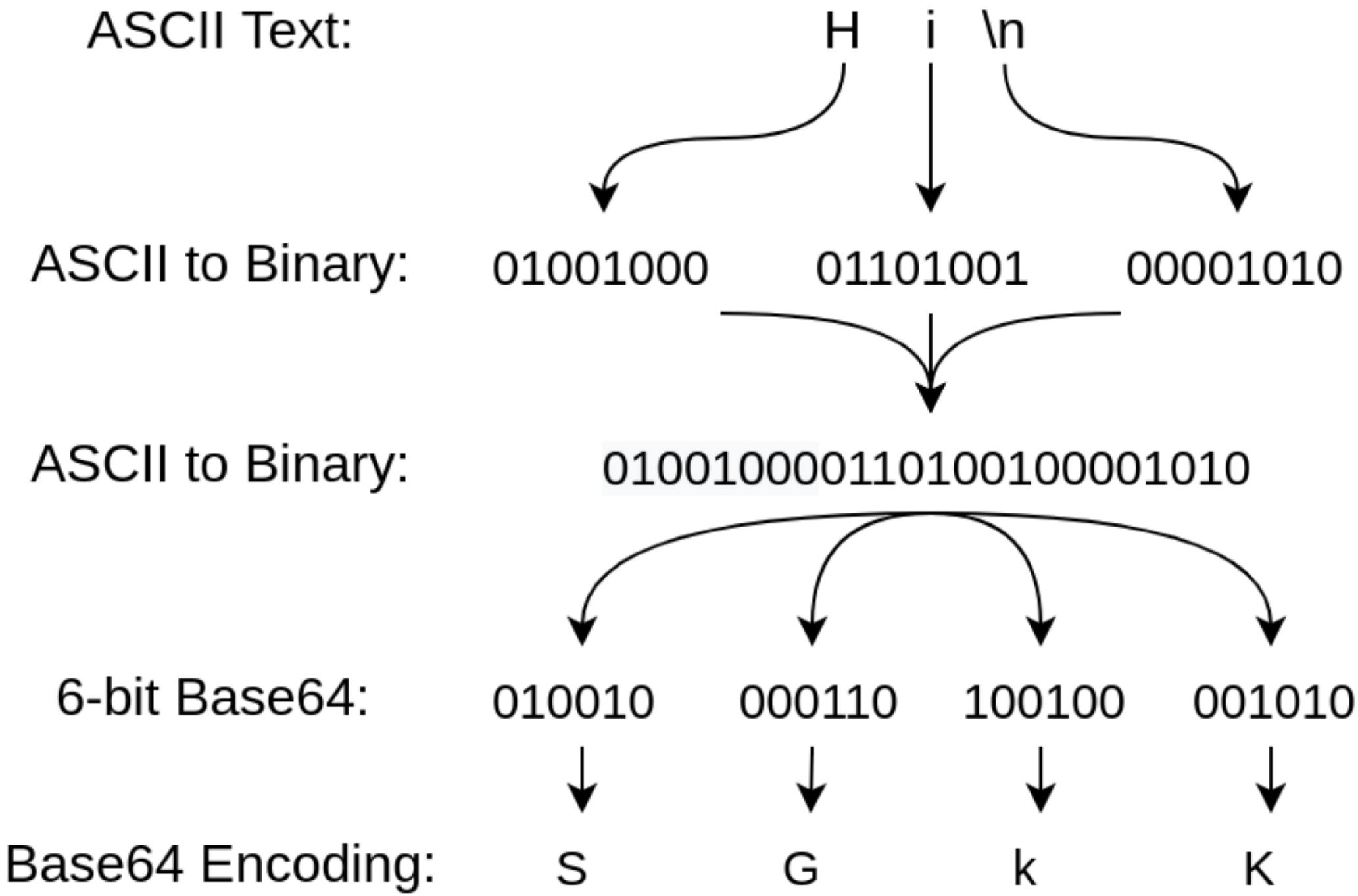
Base64 Encoding

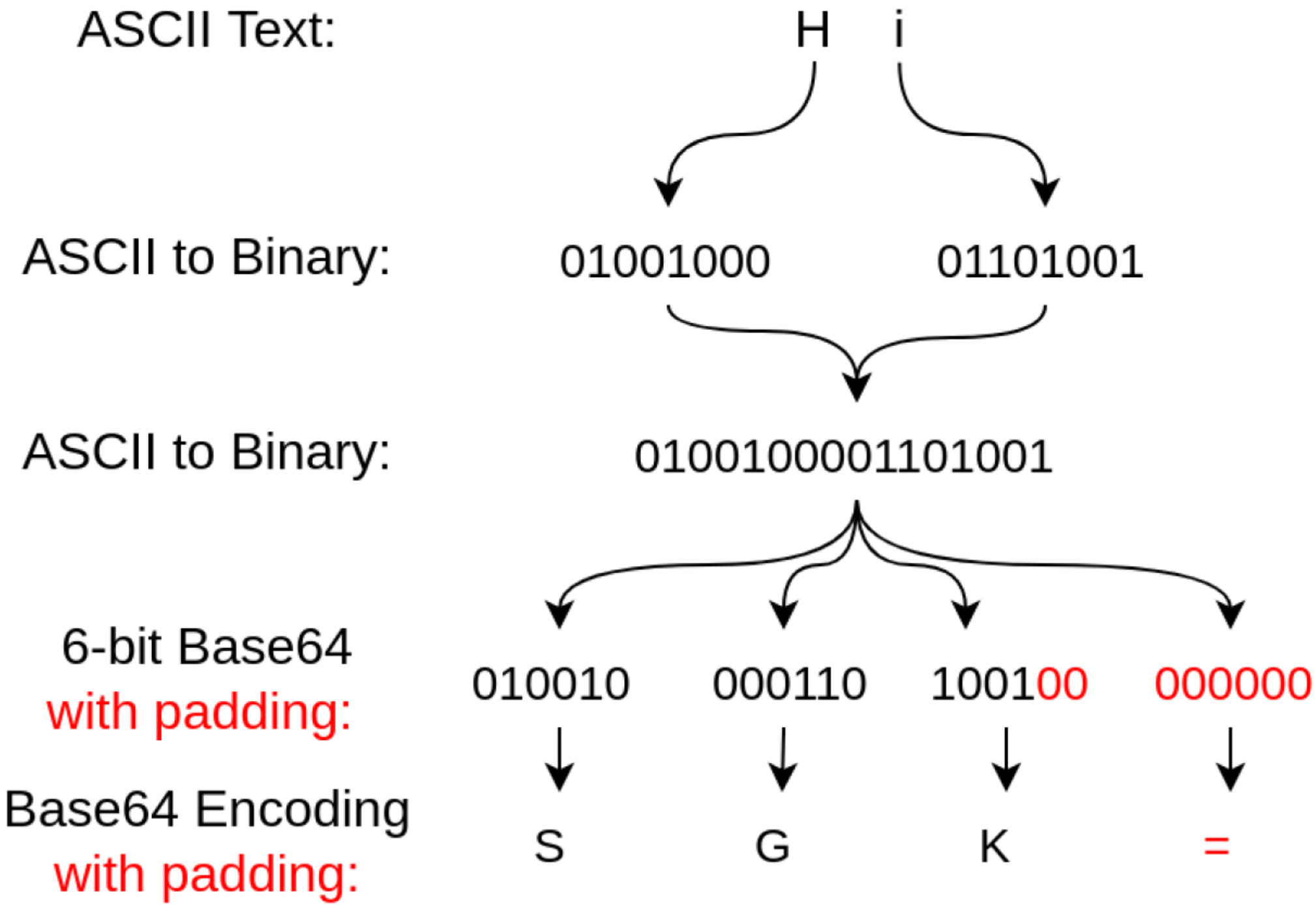

```
R0lGODlhbgA0ALMAAAAAAP///zxZdxMaIbi4uLe3t1paWnNzc3JyckBAQAAAAAAA
AAAAAAAAAAAAAAAAACH5BAAAAAAALAAAAABuADQAAAT/UMhJq7046827r0MojmRp
nmiqrmxLAnAsz3Rt33iu73zv/8CgcEgsGo/IpHLJbDqf0Kh0Sq1ar9is9lcIeL9g
cAHQDZvDhMOMcAaraYe2GMqWgwmAuv38hunbeDRldoFbhoeIiT9/dmODe2djeZB9
MHGQhU2McmObkF+BnmGSMY9ymYqpqquJZziMM6YBCDN2fZdtpFauN6ZrZjSEMaJe
qKzHyMlSvDbEzDJ7eLKjWc+Cn8U1fG5huKDK4OHiR9a/2LoxZtKAAGboVOUyzsDB
1O286uP6+/w38aVhzIGpd8cPmnQHsfyD4UuGrEr3CgLwFqCPu34YMy4xwPHItDN4
W+btYXhq2DeEuWYYiLGyiMhsL9lNSmnpS6VGMlYaSKBTIxSdLVv6bNKzJ5GYnbCZ
6UNMFxtUOHOyNPLxYsw7lapCJRiJBkehQ8OKHUu2rNmzaNOqXcu2rdstEQAAOw==
```

Index	Binary	Char	Index	Binary	Char	Index	Binary	Char	Index	Binary	Char
0	000000	A	16	010000	Q	32	100000	g	48	110000	w
1	000001	B	17	010001	R	33	100001	h	49	110001	x
2	000010	C	18	010010	S	34	100010	i	50	110010	y
3	000011	D	19	010011	T	35	100011	j	51	110011	z
4	000100	E	20	010100	U	36	100100	k	52	110100	0
5	000101	F	21	010101	V	37	100101	l	53	110101	1
6	000110	G	22	010110	W	38	100110	m	54	110110	2
7	000111	H	23	010111	X	39	100111	n	55	110111	3
8	001000	I	24	011000	Y	40	101000	o	56	111000	4
9	001001	J	25	011001	Z	41	101001	p	57	111001	5
10	001010	K	26	011010	a	42	101010	q	58	111010	6
11	001011	L	27	011011	b	43	101011	r	59	111011	7
12	001100	M	28	011100	c	44	101100	s	60	111100	8
13	001101	N	29	011101	d	45	101101	t	61	111101	9
14	001110	O	30	011110	e	46	101110	u	62	111110	+
15	001111	P	31	011111	f	47	101111	v	63	111111	/
padding		=									


ASCII Text:
H
i
\n
ASCII to Binary:
01001000
01101001
00001010
ASCII to Binary:
010010000110100100001010


ASCII Text:
H
i
\n
ASCII to Binary:
01001000
01101001
00001010
ASCII to Binary:
010010000110100100001010
6-bit Base64:
010010
000110
100100
001010


ASCII Text:
H
i
\n
ASCII to Binary:
01001000
01101001
00001010
ASCII to Binary:
010010000110100100001010
6-bit Base64:
010010
000110
100100
001010
Base64 Encoding:
S
G
k
K


ASCII Text:
H
i
ASCII to Binary:
01001000
01101001
ASCII to Binary:
0100100001101001
6-bit Base64
with padding:
010010
000110
100100
000000
Base64 Encoding
with padding:
S
G
K
=

Proj1 - Miscellaneous Requirements

- **You must not use any *external code fragments***
- **Please see Proj1 grading guideline for additional details**