

C Standard Library

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<assert.h>

```
void assert(int expression);
```

Macro used for internal error detection. (Ignored if `NDEBUG` is defined where `<assert.h>` is included.) If `expression` equals zero, message printed on `stderr` and `abort` called to terminate execution. Source filename and line number in message are from preprocessor macros `__FILE__` and `__LINE__`.

<ctype.h>

```
int isalnum(int c);
    isalpha(c) or isdigit(c)
```

```
int isalpha(int c);
    isupper(c) or islower(c)
```

```
int iscntrl(int c);
    is control character. In ASCII, control characters are 0x00 (NUL) to 0x1F (US), and 0x7F (DEL)
```

```
int isdigit(int c);
    is decimal digit
```

`int isgraph(int c);`
is printing character other than space

`int islower(int c);`
is lower-case letter

`int isprint(int c);`
is printing character (including space). In ASCII, printing characters are 0x20 (' ') to 0x7E ('~')

`int ispunct(int c);`
is printing character other than space, letter, digit

`int isspace(int c);`
is space, formfeed, newline, carriage return, tab, vertical tab

`int isupper(int c);`
is upper-case letter

`int isxdigit(int c);`
is hexadecimal digit

`int tolower(int c);`
return lower-case equivalent

`int toupper(int c);`
return upper-case equivalent

<errno.h>

errno

object to which certain library functions assign specific positive values on error

EDOM

code used for domain errors

ERANGE

code used for range errors

Notes:

- other implementation-defined error values are permitted
- to determine the value (if any) assigned to **errno** by a library function, a program should assign zero to **errno** immediately prior to the function call

<float.h>

FLT_RADIX

radix of floating-point representations

FLT_ROUNDS

floating-point rounding mode

Where the prefix FLT pertains to type float, DBL to type double, and LDBL to type long double:

FLT_DIG

DBL_DIG

LDBL_DIG

precision (in decimal digits)

FLT_EPSILON

DBL_EPSILON

LDBL_EPSILON

smallest number x such that $1.0 + x \neq 1.0$

FLT_MANT_DIG

DBL_MANT_DIG

LDBL_MANT_DIG

number of digits, base FLT_RADIX, in mantissa

FLT_MAX

DBL_MAX

LDBL_MAX

maximum number

FLT_MAX_EXP

DBL_MAX_EXP

LDBL_MAX_EXP

largest positive integer exponent to which FLT_RADIX can be raised and remain representable

FLT_MIN

DBL_MIN

LDBL_MIN

minimum normalised number

FLT_MIN_EXP

DBL_MIN_EXP

LDBL_MIN_EXP

smallest negative integer exponent to which FLT_RADIX can be raised and remain representable

<limits.h>

CHAR_BIT

number of bits in a char

CHAR_MAX

maximum value of type char

CHAR_MIN

minimum value of type char

SCHAR_MAX

maximum value of type signed char

SCHAR_MIN

minimum value of type signed char

UCHAR_MAX

maximum value of type `unsigned char`

`SHRT_MAX`
maximum value of type `short`

`SHRT_MIN`
minimum value of type `short`

`USHRT_MAX`
maximum value of type `unsigned short`

`INT_MAX`
maximum value of type `int`

`INT_MIN`
minimum value of type `int`

`UINT_MAX`
maximum value of type `unsigned int`

`LONG_MAX`
maximum value of type `long`

`LONG_MIN`
minimum value of type `long`

`ULONG_MAX`
maximum value of type `unsigned long`

<locale.h>

`struct lconv`

Describes formatting of monetary and other numeric values:

```
char *decimal_point;  
    decimal point for non-monetary values
```

```
char *grouping;  
    sizes of digit groups for non-monetary values
```

```
char *thousands_sep;  
    separator for digit groups for non-monetary values (left of "decimal point")
```

```
char *currency_symbol;  
    currency symbol
```

```
char *int_curr_symbol;  
    international currency symbol
```

```
char *mon_decimal_point;  
    decimal point for monetary values
```

```
char *mon_grouping;  
    sizes of digit groups for monetary values
```

```
char *mon_thousands_sep;  
    separator for digit groups for monetary values (left of "decimal point")
```

```
char *negative_sign;
```

negative sign for monetary values

`char *positive_sign;`
positive sign for monetary values

`char frac_digits;`
number of digits to be displayed to right of “decimal point” for monetary values

`char int_frac_digits;`
number of digits to be displayed to right of ”decimal point” for international monetary values

`char n_cs_precedes;`
whether currency symbol precedes (1) or follows (0) negative monetary values

`char n_sep_by_space;`
whether currency symbol is (1) or is not (0) separated by space from negative monetary values

`char n_sign_posn;`
format for negative monetary values:

- 0 parentheses surround quantity and currency symbol
- 1 sign precedes quantity and currency symbol
- 2 sign follows quantity and currency symbol
- 3 sign immediately precedes currency symbol
- 4 sign immediately follows currency symbol

`char p_cs_precedes;`
whether currency symbol precedes (1) or follows (0) positive monetary values

`char p_sep_by_space;`
whether currency symbol is (1) or is not (0) separated by space from non-negative monetary values

`char p_sign_posn;`
format for non-negative monetary values, with values as for `n_sign_posn`

Implementations may change field order and include additional fields. Standard C Library functions use only `decimal_point`.

`struct lconv *localeconv(void);`
returns pointer to formatting information for current locale

`char *setlocale(int category, const char *locale);`
Sets components of locale according to specified category and locale. Returns string describing new locale or NULL on error. (Implementations are permitted to define values of category additional to those describe here.)

`LC_ALL`
category argument for all categories

`LC_NUMERIC`

category for numeric formatting information

LC_MONETARY

category for monetary formatting information

LC_COLLATE

category for information affecting collating functions

LC_CTYPE

category for information affecting character class tests functions

LC_TIME

category for information affecting time conversions functions

NULL

null pointer constant

<math.h>

On domain error, implementation-defined value returned and `errno` set to `EDOM`. On range error, `errno` set to `ERANGE` and return value is `HUGE_VAL` with correct sign for overflow, or zero for underflow. *Angles are in radians.*

HUGE_VAL

magnitude returned (with correct sign) on overflow error

`double exp(double x);`

exponential of x

`double log(double x);`

natural logarithm of x

`double log10(double x);`

base-10 logarithm of x

`double pow(double x, double y);`

x raised to power y

`double sqrt(double x);`

square root of x

`double ceil(double x);`

smallest integer not less than x

`double floor(double x);`

largest integer not greater than x

`double fabs(double x);`

absolute value of x

`double ldexp(double x, int n);`

x times 2 to the power n

`double frexp(double x, int *exp);`

if x non-zero, returns value, with absolute value in interval $[1/2, 1)$, and assigns to `*exp` integer such that product of return value and 2 raised to the power `*exp` equals x; if x zero, both return value and `*exp` are zero

`double modf(double x, double *ip);`
 returns fractional part and assigns to *ip integral part of x, both with same sign as x

`double fmod(double x, double y);`
 if y non-zero, floating-point remainder of x/y, with same sign as x; if y zero, result is implementation-defined

`double sin(double x);`
 sine of x

`double cos(double x);`
 cosine of x

`double tan(double x);`
 tangent of x

`double asin(double x);`
 arc-sine of x

`double acos(double x);`
 arc-cosine of x

`double atan(double x);`
 arc-tangent of x

`double atan2(double y, double x);`
 arc-tangent of y/x

`double sinh(double x);`
 hyperbolic sine of x

`double cosh(double x);`
 hyperbolic cosine of x

`double tanh(double x);`
 hyperbolic tangent of x

<stddef.h>

`NULL`

Null pointer constant.

`offsetof(stype, m)`

Offset (in bytes) of member m from start of structure type stype.

`ptrdiff_t`

Type for objects declared to store result of subtracting pointers.

`size_t`

Type for objects declared to store result of sizeof operator.

<stdio.h>

`BUFSIZ`

Size of buffer used by `setbuf`.

EOF

Value used to indicate end-of-stream or to report an error.

FILENAME_MAX

Maximum length required for array of characters to hold a filename.

FOPEN_MAX

Maximum number of files which may be open simultaneously.

L_tmpnam

Number of characters required for temporary filename generated by `tmpnam`.

NULL

Null pointer constant.

SEEK_CUR

Value for origin argument to `fseek` specifying current file position.

SEEK_END

Value for origin argument to `fseek` specifying end of file.

SEEK_SET

Value for origin argument to `fseek` specifying beginning of file.

TMP_MAX

Minimum number of unique filenames generated by calls to `tmpnam`.

_IOFBF

Value for mode argument to `setvbuf` specifying full buffering.

_IOLBF

Value for mode argument to `setvbuf` specifying line buffering.

_IONBF

Value for mode argument to `setvbuf` specifying no buffering.

stdin

File pointer for standard input stream. Automatically opened when program execution begins.

stdout

File pointer for standard output stream. Automatically opened when program execution begins.

stderr

File pointer for standard error stream. Automatically opened when program execution begins.

FILE

Type of object holding information necessary to control a stream.

fpos_t

Type for objects declared to store file position information.

size_t

Type for objects declared to store result of `sizeof` operator.

FILE *fopen(const char *filename, const char *mode);

Opens file named `filename` and returns a stream, or `NULL` on failure. `mode` may be one of the following for text files:

`"r"`

text reading
 "w"
 text writing
 "a"
 text append
 "r+"
 text update (reading and writing)
 "w+"
 text update, discarding previous content (if any)
 "a+"
 text append, reading, and writing at end

or one of those strings with b included (after the first character), for binary files.

FILE *freopen(const char *filename, const char *mode, FILE *stream);

Closes file associated with stream, then opens file filename with specified mode and associates it with stream. Returns stream or NULL on error.

int fflush(FILE *stream);

Flushes stream stream and returns zero on success or EOF on error. Effect undefined for input stream. fflush(NULL) flushes all output streams.

int fclose(FILE *stream);

Closes stream stream (after flushing, if output stream). Returns EOF on error, zero otherwise.

int remove(const char *filename);

Removes specified file. Returns non-zero on failure.

int rename(const char *oldname, const char *newname);

Changes name of file oldname to newname. Returns non-zero on failure.

FILE *tmpfile();

Creates temporary file (mode "wb+") which will be removed when closed or on normal program termination. Returns stream or NULL on failure.

char *tmpnam(char s[L_tmpnam]);

Assigns to s (if s non-null) and returns unique name for a temporary file. Unique name is returned for each of the first TMP_MAX invocations.

int setvbuf(FILE *stream, char *buf, int mode, size_t size);

Controls buffering for stream stream. mode is _IOFBF for full buffering, _IOLBF for line buffering, _IONBF for no buffering. Non-null buf specifies buffer of size size to be used; otherwise, a buffer is allocated. Returns non-zero on error. Call must be before any other operation on stream.

void setbuf(FILE *stream, char *buf);

Controls buffering for stream stream. For null buf, turns off buffering, otherwise equivalent to (void)setvbuf(stream, buf, _IOFBF, BUFSIZ).

int fprintf(FILE *stream, const char *format, ...);

Converts (according to format format) and writes output to stream stream. Number of characters written, or negative value on error, is returned. Conversion specifications consist of:

- %

- (optional) flag:
 - left adjust
 - + always sign
 - space space if no sign
 - 0 zero pad
 - # Alternate form: for conversion character o, first digit will be zero, for [xX], prefix 0x or 0X to non-zero value, for [eEfgG], always decimal point, for [gG] trailing zeros not removed.
- (optional) minimum width: if specified as *, value taken from next argument (which must be int).
- (optional) . (separating width from precision):
- (optional) precision: for conversion character s, maximum characters to be printed from the string, for [eEf], digits after decimal point, for [gG], significant digits, for an integer, minimum number of digits to be printed. If specified as *, value taken from next argument (which must be int).
- (optional) length modifier:
 - h short or unsigned short
 - l long or unsigned long
 - L long double
- conversion character:
 - d,i int argument, printed in signed decimal notation
 - o int argument, printed in unsigned octal notation
 - x,X int argument, printed in unsigned hexadecimal notation
 - u int argument, printed in unsigned decimal notation
 - c int argument, printed as single character
 - s char *argument
 - f double argument, printed with format [-]mmm.ddd
 - e,E double argument, printed with format [-]m.ddddd(e|E)(+|-)xx
 - g,G double argument
 - p void *argument, printed as pointer
 - n

int *argument : the number of characters written to this point is written into argument

%
no argument; prints %

int printf(const char *format, ...);
printf(f, ...) is equivalent to fprintf(stdout, f, ...)

int sprintf(char *s, const char *format, ...);
Like fprintf, but output written into string s, which must be large enough to hold the output, rather than to a stream. Output is NUL-terminated. Returns length (excluding the terminating NUL).

int vfprintf(FILE *stream, const char *format, va_list arg);
Equivalent to fprintf with variable argument list replaced by arg, which must have been initialised by the va_start macro (and may have been used in calls to va_arg).

int vprintf(const char *format, va_list arg);
Equivalent to printf with variable argument list replaced by arg, which must have been initialised by the va_start macro (and may have been used in calls to va_arg).

int vsprintf(char *s, const char *format, va_list arg);
Equivalent to sprintf with variable argument list replaced by arg, which must have been initialised by the va_start macro (and may have been used in calls to va_arg).

int fscanf(FILE *stream, const char *format, ...);
Performs formatted input conversion, reading from stream stream according to format format. The function returns when format is fully processed. Returns number of items converted and assigned, or EOF if end-of-file or error occurs before any conversion. Each of the arguments following format must be a pointer. Format string may contain:

- blanks and tabs, which are ignored
- ordinary characters, which are expected to match next non-white-space of input conversion specifications, consisting of:
 - %
 - (optional) assignment suppression character "*"
 - (optional) maximum field width
 - (optional) target width indicator:
 - h argument is pointer to short rather than int
 - l argument is pointer to long rather than int, or double rather than float
 - L argument is pointer to long double rather than float
 - conversion character:
 - d decimal integer; int *parameter required
 - i integer; int *parameter required; decimal, octal or hex
 - o octal integer; int *parameter required
 - u unsigned decimal integer; unsigned int *parameter required
 - x

hexadecimal integer; int *parameter required

c characters; char *parameter required; white-space is not skipped, and NUL-termination is not performed

s string of non-white-space; char *parameter required; string is NUL-terminated

e, f, g floating-point number; float *parameter required

p pointer value; void *parameter required

n chars read so far; int *parameter required

[. . .] longest non-empty string from specified set; char *parameter required; string is NUL-terminated

[^ . . .] longest non-empty string not from specified set; char *parameter required; string is NUL-terminated

% literal %; no assignment

```
int scanf(const char *format, ...);
```

scanf(f, ...) is equivalent to fscanf(stdin, f, ...)

```
int sscanf(char *s, const char *format, ...);
```

Like fscanf, but input read from string s.

```
int fgetc(FILE *stream);
```

Returns next character from (input) stream stream, or EOF on end-of-file or error.

```
char *fgets(char *s, int n, FILE *stream);
```

Copies characters from (input) stream stream to s, stopping when n-1 characters copied, newline copied, end-of-file reached or error occurs. If no error, s is NUL-terminated. Returns NULL on end-of-file or error, s otherwise.

```
int fputc(int c, FILE *stream);
```

Writes c, to stream stream. Returns c, or EOF on error.

```
char *fputs(const char *s, FILE *stream);
```

Writes s, to (output) stream stream. Returns non-negative on success or EOF on error.

```
int getc(FILE *stream);
```

Equivalent to fgetc except that it may be a macro.

```
int getchar(void);
```

Equivalent to getc(stdin).

```
char *gets(char *s);
```

Copies characters from stdin into s until newline encountered, end-of-file reached, or error occurs. Does not copy newline. NUL-terminates s. Returns s, or NULL on end-of-file or error. Should not be used because of the potential for buffer overflow.

```
int putc(int c, FILE *stream);
```

Equivalent to fputc except that it may be a macro.

```
int putchar(int c);
```

putchar(c) is equivalent to putc(c, stdout).

```
int puts(const char *s);
```

Writes *s* (excluding terminating NUL) and a newline to `stdout`. Returns non-negative on success, EOF on error.

```
int ungetc(int c, FILE *stream);
```

Pushes *c* (which must not be EOF), onto (input) stream *stream* such that it will be returned by the next read. Only one character of pushback is guaranteed (for each stream). Returns *c*, or EOF on error.

```
size_t fread(void *ptr, size_t size, size_t nobj, FILE *stream);
```

Reads (at most) *nobj* objects of size *size* from stream *stream* into *ptr* and returns number of objects read. (`feof` and `ferror` can be used to check status.)

```
size_t fwrite(const void *ptr, size_t size, size_t nobj, FILE *stream);
```

Writes to stream *stream*, *nobj* objects of size *size* from array *ptr*. Returns number of objects written.

```
int fseek(FILE *stream, long offset, int origin);
```

Sets file position for stream *stream* and clears end-of-file indicator. For a binary stream, file position is set to *offset* bytes from the position indicated by *origin*: beginning of file for `SEEK_SET`, current position for `SEEK_CUR`, or end of file for `SEEK_END`. Behaviour is similar for a text stream, but *offset* must be zero or, for `SEEK_SET` only, a value returned by `ftell`. Returns non-zero on error.

```
long ftell(FILE *stream);
```

Returns current file position for stream *stream*, or -1 on error.

```
void rewind(FILE *stream);
```

Equivalent to `fseek(stream, 0L, SEEK_SET); clearerr(stream)`.

```
int fgetpos(FILE *stream, fpos_t *ptr);
```

Stores current file position for stream *stream* in **ptr*. Returns non-zero on error.

```
int fsetpos(FILE *stream, const fpos_t *ptr);
```

Sets current position of stream *stream* to **ptr*. Returns non-zero on error.

```
void clearerr(FILE *stream);
```

Clears end-of-file and error indicators for stream *stream*.

```
int feof(FILE *stream);
```

Returns non-zero if end-of-file indicator is set for stream *stream*.

```
int ferror(FILE *stream);
```

Returns non-zero if error indicator is set for stream *stream*.

```
void perror(const char *s);
```

Prints *s* (if non-null) and `strerror(errno)` to standard error as would:

```
fprintf(stderr, "%s: %s\n", (s != NULL ? s : ""), strerror(errno))
```

<stdlib.h>

`EXIT_FAILURE`

Value for status argument to `exit` indicating failure.

`EXIT_SUCCESS`

Value for status argument to `exit` indicating success.

RAND_MAX

Maximum value returned by rand().

NULL

Null pointer constant.

div_t

Return type of div(). Structure having members:

```
int quot;
    quotient
int rem;
    remainder
```

ldiv_t Return type of ldiv(). Structure having members:

```
long quot;
    quotient
long rem;
    remainder
```

size_t

Type for objects declared to store result of sizeof operator.

```
int abs(int n);
```

```
labs(long n);
```

Returns absolute value of n.

```
div_t div(int num, int denom);
```

```
ldiv_t ldiv(long num, long denom);
```

Returns quotient and remainder of num/denom.

```
double atof(const char *s);
```

Equivalent to strtod(s, (char **)NULL) except that errno is not necessarily set on conversion error.

```
int atoi(const char *s);
```

Equivalent to (int)strtol(s, (char **)NULL, 10) except that errno is not necessarily set on conversion error.

```
long atol(const char *s);
```

Equivalent to strtol(s, (char **)NULL, 10) except that errno is not necessarily set on conversion error.

```
double strtod(const char *s, char **endp);
```

Converts initial characters (ignoring leading white space) of s to type double. If endp non-null, stores pointer to unconverted suffix in *endp. On overflow, sets errno to ERANGE and returns HUGE_VAL with the appropriate sign; on underflow, sets errno to ERANGE and returns zero; otherwise returns converted value.

```
long strtol(const char *s, char *endp, int base);
```

Converts initial characters (ignoring leading white space) of s to type long. If endp non-null, stores pointer to unconverted suffix in *endp. If base between 2 and 36, that base used for conversion; if zero, leading (after any sign) 0X or 0x implies hexadecimal, leading 0 (after any sign)

implies octal, otherwise decimal assumed. Leading 0X or 0x permitted for base hexadecimal. On overflow, sets `errno` to `ERANGE` and returns `LONG_MAX` or `LONG_MIN` (as appropriate for sign); otherwise returns converted value.

```
unsigned long strtoul(const char *s, char **endp, int base);
```

As for `strtoul` except result is unsigned long and value on overflow is `ULONG_MAX`.

```
void *calloc(size_t nobj, size_t size);
```

Returns pointer to zero-initialised newly-allocated space for an array of `nobj` objects each of size `size`, or `NULL` on error.

```
void *malloc(size_t size);
```

Returns pointer to uninitialised newly-allocated space for an object of size `size`, or `NULL` on error.

```
void *realloc(void *p, size_t size);
```

Returns pointer to newly-allocated space for an object of size `size`, initialised, to minimum of old and new sizes, to existing contents of `p` (if non-null), or `NULL` on error. On success, old object deallocated, otherwise unchanged.

```
void free(void *p);
```

If `p` non-null, deallocates space to which it points.

```
void abort();
```

Terminates program abnormally, by calling `raise(SIGABRT)`.

```
void exit(int status);
```

Terminates program normally. Functions installed using `atexit` are called (in reverse order to that in which installed), open files are flushed, open streams are closed and control is returned to environment. `status` is returned to environment in implementation-dependent manner. Zero or `EXIT_SUCCESS` indicates successful termination and `EXIT_FAILURE` indicates unsuccessful termination. Implementations may define other values.

```
int atexit(void (*fcm)(void));
```

Registers `fcm` to be called when program terminates normally (or when `main` returns). Returns non-zero on failure.

```
int system(const char *s);
```

If `s` is not `NULL`, passes `s` to environment for execution, and returns status reported by command processor; if `s` is `NULL`, non-zero returned if environment has a command processor.

```
char *getenv(const char *name);
```

Returns string associated with name `name` from implementation's environment, or `NULL` if no such string exists.

```
void *bsearch(const void *key, const void *base, size_t n, size_t size, int (*cmp)(const void *, const void *), const void *datum);
```

Searches ordered array `base` (of `n` objects each of size `size`) for item matching `key` according to comparison function `cmp`. `cmp` must return negative value if first argument is less than second, zero if equal and positive if greater. Items of `base` are assumed to be in ascending order (according to `cmp`). Returns a pointer to an item matching `key`, or `NULL` if none found.

```
void qsort(void *base, size_t n, size_t size, int (*cmp)(const void *, const void *));
```

Arranges into ascending order array `base` (of `n` objects each of size `size`) according to comparison function `cmp`. `cmp` must return negative value if first argument is less than second, zero if equal and positive if greater.

`int rand(void);`

Returns pseudo-random number in range 0 to RAND_MAX.

`void srand(unsigned int seed);`

Uses seed as seed for new sequence of pseudo-random numbers. Initial seed is 1.

<string.h>

`NULL`

Null pointer constant.

`size_t`

Type for objects declared to store result of sizeof operator.

`char *strcpy(char *s, const char *ct);`

Copies ct to s including terminating NUL and returns s.

`char *strncpy(char *s, const char *ct, size_t n);`

Copies at most n characters of ct to s. Pads with NUL characters if ct is of length less than n.

Note that this may leave s without NUL-termination. Return s.

`char *strcat(char *s, const char *ct);`

Concatenate ct to s and return s.

`char *strncat(char *s, const char *ct, size_t n);`

Concatenate at most n characters of ct to s. NUL-terminates s and return it.

`int strcmp(const char *cs, const char *ct);`

Compares cs with ct, returning negative value if cs<ct, zero if cs==ct, positive value if cs>ct.

`int strncmp(const char *cs, const char *ct, size_t n);`

Compares at most (the first) n characters of cs and ct, returning negative value if cs<ct, zero if cs==ct, positive value if cs>ct.

`int strcoll(const char *cs, const char *ct);`

Compares cs with ct according to locale, returning negative value if cs<ct, zero if cs==ct, positive value if cs>ct.

`char *strchr(const char *cs, int c);`

Returns pointer to first occurrence of c in cs, or NULL if not found.

`char *strrchr(const char *cs, int c);`

Returns pointer to last occurrence of c in cs, or NULL if not found.

`size_t strspn(const char *cs, const char *ct);`

Returns length of prefix of cs which consists of characters which are in ct.

`size_t strcspn(const char *cs, const char *ct);`

Returns length of prefix of cs which consists of characters which are not in ct.

`char *strpbrk(const char *cs, const char *ct);`

Returns pointer to first occurrence in cs of any character of ct, or NULL if none is found.

`char *strstr(const char *cs, const char *ct);`

Returns pointer to first occurrence of ct within cs, or NULL if none is found.

`size_t strlen(const char *cs);`

Returns length of cs.

```
char *strerror(int n);
```

Returns pointer to implementation-defined message string corresponding with error n.

```
char *strtok(char *s, const char *t);
```

Searches s for next token delimited by any character from ct. Non-NULL s indicates the first call of a sequence. If a token is found, it is NUL-terminated and returned, otherwise NULL is returned. ct need not be identical for each call in a sequence.

```
size_t strxfrm(char *s, const char *ct, size_t n);
```

Stores in s no more than n characters (including terminating NUL) of a string produced from ct according to a locale-specific transformation. Returns length of entire transformed string.

```
void *memcpy(void *s, const void *ct, size_t n);
```

Copies n characters from ct to s and returns s. s may be corrupted if objects overlap.

```
void *memmove(void *s, const void *ct, size_t n);
```

Copies n characters from ct to s and returns s. s will not be corrupted if objects overlap.

```
int memcmp(const void *cs, const void *ct, size_t n);
```

Compares at most (the first) n characters of cs and ct, returning negative value if cs<ct, zero if cs==ct, positive value if cs>ct.

```
void *memchr(const void *cs, int c, size_t n);
```

Returns pointer to first occurrence of c in first n characters of cs, or NULL if not found.

```
void *memset(void *s, int c, size_t n);
```

Replaces each of the first n characters of s by c and returns s.

<time.h>

CLOCKS_PER_SEC

The number of clock_t units per second.

NULL

Null pointer constant.

clock_t

An arithmetic type elapsed processor representing time.

time_t

An arithmetic type representing calendar time.

struct tm

Represents the components of calendar time:

```
int tm_sec;
    seconds after the minute

int tm_min;
    minutes after the hour

int tm_hour;
    hours since midnight

int tm_mday;
```

day of the month
int tm_mon;
 months since January
int tm_year;
 years since 1900
int tm_wday;
 days since Sunday
int tm_yday;
 days since January 1
int tm_isdst;
 Daylight Saving Time flag : is positive if DST is in effect, zero if not in effect, negative if information not known.

Implementations may change field order and include additional fields.

clock_t clock(void);

Returns elapsed processor time used by program or -1 if not available.

time_t time(time_t *tp);

Returns current calendar time or -1 if not available. If tp is non-NULL, return value is also assigned to *tp.

double difftime(time_t time2, time_t time1);

Returns the difference in seconds between time2 and time1.

time_t mktime(struct tm *tp);

If necessary, adjusts fields of *tp to fall within normal ranges. Returns the corresponding calendar time, or -1 if it cannot be represented.

char *asctime(const struct tm *tp);

Returns the given time as a string of the form:

Sun Jan 3 13:08:42 1988\n\0

char *ctime(const time_t *tp);

Returns string equivalent to calendar time tp converted to local time. Equivalent to: asctime(localtime(tp))

struct tm *gmtime(const time_t *tp);

Returns calendar time *tp converted to Coordinated Universal Time, or NULL if not available.

struct tm *localtime(const time_t *tp);

Returns calendar time *tp converted into local time.

size_t strftime(char *s, size_t smax, const char *fmt, const struct tm *tp);

Formats *tp into s according to fmt. Places no more than smax characters into s, and returns number of characters produced (excluding terminating NUL), or 0 if greater than smax. Formatting conversions (%c) are:

- A name of weekday
- a abbreviated name of weekday

B	name of month
b	abbreviated name of month
c	local date and time representation
d	day of month [01-31]
H	hour (24-hour clock) [00-23]
I	hour (12-hour clock) [01-12]
j	day of year [001-366]
M	minute [00-59]
m	month [01-12]
p	local equivalent of "AM" or "PM"
S	second [00-61]
U	week number of year (Sunday as 1st day of week) [00-53]
W	week number of year (Monday as 1st day of week) [00-53]
w	weekday (Sunday as 0) [0-6]
X	local time representation
x	local date representation
Y	year with century
y	year without century [00-99]
Z	name (if any) of time zone
%	%

Local time may differ from calendar time because of time zone.