

UNIX PROGRAMMER'S MANUAL

Fifth Edition

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This manual was set by a Graphic Systems phototypesetter driven by the *troff* formatting program operating under the UNIX system. The text of the manual was prepared using the *ed* text editor.

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PREFACE
to the Fifth Edition

The number of UNIX installations is now above 50, and many more are expected. None of these has exactly the same complement of hardware or software. Therefore, at any particular installation, it is quite possible that this manual will give inappropriate information.

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INTRODUCTION TO THIS MANUAL

This manual gives descriptions of the publicly available features of UNIX. It provides neither a general overview – see “The UNIX Time-sharing System” for that – nor details of the implementation of the system, (which remain to be disclosed).

Within the area it surveys, this manual attempts to be as complete and timely as possible. A conscious decision was made to describe each program in exactly the state it was in at the time its manual section was prepared. In particular, the desire to describe something as it should be, not as it is, was resisted. Inevitably, this means that many sections will soon be out of date.

This manual is divided into eight sections:

- I. Commands
- II. System calls
- III. Subroutines
- IV. Special files
- V. File formats
- VI. User-maintained programs
- VII. Miscellaneous
- VIII. Maintenance

Commands are programs intended to be invoked directly by the user, in contradistinction to subroutines, which are intended to be called by the user’s programs. Commands generally reside in directory */bin* (for binary programs). Some programs also reside in */usr/bin*, to save space in */bin*. Some programs classified as commands are located elsewhere; this fact is indicated in the appropriate sections.

System calls are entries into the UNIX supervisor. In assembly language, they are coded with the use of the opcode *sys*, a synonym for the *trap* instruction. In this edition, the C language interface routines to the system calls have been incorporated in section II.

A small assortment of subroutines is available; they are described in section III. The binary form of most of them is kept in the system library */lib/liba.a*. The subroutines available from C and from Fortran are also included; they reside in */lib/libc.a* and */lib/libf.a* respectively.

The special files section IV discusses the characteristics of each system “file” which actually refers to an I/O device. The names in this section refer to the DEC device names for the hardware, instead of the names of the special files themselves.

The file formats and conventions section V documents the structure of particular kinds of files; for example, the form of the output of the loader and assembler is given. Excluded are files used by only one command, for example the assembler’s intermediate files.

User-maintained programs (section VI) are not considered part of the UNIX system, and the principal reason for listing them is to indicate their existence without necessarily giving a complete description. The author should be consulted for information.

The miscellaneous section (VII) gathers odds and ends.

Section VIII discusses commands which are not intended for use by the ordinary user, in some cases because they disclose information in which he is presumably not interested, and in others because they perform privileged functions.

Each section consists of a number of independent entries of a page or so each. The name of the entry is in the upper corners of its pages, its preparation date in the upper middle. Entries within each section are alphabetized. The page numbers of each entry start at 1. (The earlier hope for frequent, partial updates of the manual is clearly in vain, but in any event it is not feasible to maintain consecutive page numbering in a

document like this.)

All entries are based on a common format, not all of whose subsections will always appear.

The *name* section repeats the entry name and gives a very short description of its purpose.

The *synopsis* summarizes the use of the program being described. A few conventions are used, particularly in the Commands section:

Boldface words are considered literals, and are typed just as they appear.

Square brackets ([]) around an argument indicate that the argument is optional. When an argument is given as “name”, it always refers to a file name.

Ellipses “...” are used to show that the previous argument-prototype may be repeated.

A final convention is used by the commands themselves. An argument beginning with a minus sign “_” is often taken to mean some sort of flag argument even if it appears in a position where a file name could appear. Therefore, it is unwise to have files whose names begin with “_”.

The *description* section discusses in detail the subject at hand.

The *files* section gives the names of files which are built into the program.

A *see also* section gives pointers to related information.

A *diagnostics* section discusses the diagnostic indications which may be produced. Messages which are intended to be self-explanatory are not listed.

The *bugs* section gives known bugs and sometimes deficiencies. Occasionally also the suggested fix is described.

At the beginning of this document is a table of contents, organized by section and alphabetically within each section. There is also a permuted index derived from the table of contents. Within each index entry, the title of the writeup to which it refers is followed by the appropriate section number in parentheses. This fact is important because there is considerable name duplication among the sections, arising principally from commands which exist only to exercise a particular system call.

This manual was prepared using the UNIX text editor *ed* and the formatting program *troff*.

HOW TO GET STARTED

This section provides the basic information you need to get started on UNIX: how to log in and log out, how to communicate through your terminal, and how to run a program.

Logging in. You must call UNIX from an appropriate terminal. UNIX supports ASCII terminals typified by the TTY 37, the GE Terminet 300, the Memorex 1240, and various graphical terminals. You must also have a valid user name, which may be obtained, together with the telephone number, from the system administrators. The same telephone number serves terminals operating at all the standard speeds. After a data connection is established, the login procedure depends on what kind of terminal you are using.

300-baud terminals: Such terminals include the GE Terminet 300, most display terminals, Execuport, TI, and certain Anderson-Jacobson terminals. These terminals generally have a speed switch which should be set at “300” (or “30” for 30 characters per second) and a half/full duplex switch which should be set at full-duplex. (This switch will often have to be changed since many other systems require half-duplex). When a connection is established, the system types “login:”; you type your user name, followed by the “return” key. If you have a password, the system asks for it and turns off the printer on the terminal so the password will not appear. After you have logged in, the “return”, “new line”, or “linefeed” keys will give exactly the same results.

TTY 37 terminal: When you have established a data connection, the system types out a few garbage characters (the “login:” message at the wrong speed). Depress the “break” (or “interrupt”) key; this is a speed-independent signal to UNIX that a 150-baud terminal is in use. The system then will type “login:,” this time at the correct speed; you respond with your user name. From the TTY 37 terminal, and any other which has the “new-line” function (combined carriage return and linefeed), terminate each line you type with the “new-line” key (*not* the “return” key).

For all these terminals, it is important that you type your name in lower-case if possible; if you type upper-case letters, UNIX will assume that your terminal cannot generate lower-case letters and will translate all subsequent upper-case letters to lower case.

The evidence that you have successfully logged in is that the Shell program will type a “%” to you. (The Shell is described below under “How to run a program.”)

For more information, consult *getty* (VIII), which discusses the login sequence in more detail, and *ty* (IV), which discusses typewriter I/O.

Logging out. There are three ways to log out:

You can simply hang up the phone.

You can log out by typing an end-of-file indication (EOT character, control “d”) to the Shell. The Shell will terminate and the “login:” message will appear again.

You can also log in directly as another user by giving a *login* command (I).

How to communicate through your terminal. When you type to UNIX, a gnome deep in the system is gathering your characters and saving them in a secret place. The characters will not be given to a program until you type a return (or new-line), as described above in *Logging in*.

UNIX typewriter I/O is full-duplex. It has full read-ahead, which means that you can type at any time, even while a program is typing at you. Of course, if you type during output, the output will have the input characters interspersed. However, whatever you type will be saved up and interpreted in correct sequence. There is a limit to the amount of read-ahead, but it is generous and not likely to be exceeded unless the system is in trouble. When the read-ahead limit is exceeded, the system throws away all the saved characters.

On a typewriter input line, the character “@” kills all the characters typed before it, so typing mistakes can be repaired on a single line. Also, the character “#” erases the last character typed. Successive uses of “#” erase characters back to, but not beyond, the beginning of the line. “@” and “#” can be transmitted

to a program by preceding them with “\”. (So, to erase “\”, you need two “#”s).

The ASCII “delete” (a.k.a. “rubout”) character is not passed to programs but instead generates an *interrupt signal*. This signal generally causes whatever program you are running to terminate. It is typically used to stop a long printout that you don’t want. However, programs can arrange either to ignore this signal altogether, or to be notified when it happens (instead of being terminated). The editor, for example, catches interrupts and stops what it is doing, instead of terminating, so that an interrupt can be used to halt an editor printout without losing the file being edited.

The *quit* signal is generated by typing the ASCII FS character. It not only causes a running program to terminate but also generates a file with the core image of the terminated process. Quit is useful for debugging.

Besides adapting to the speed of the terminal, UNIX tries to be intelligent about whether you have a terminal with the new-line function or whether it must be simulated with carriage-return and line-feed. In the latter case, all input carriage returns are turned to new-line characters (the standard line delimiter) and both a carriage return and a line feed are echoed to the terminal. If you get into the wrong mode, the *stty* command (I) will rescue you.

Tab characters are used freely in UNIX source programs. If your terminal does not have the tab function, you can arrange to have them turned into spaces during output, and echoed as spaces during input. The system assumes that tabs are set every eight columns. Again, the *stty* command (I) will set or reset this mode. Also, there is a file which, if printed on TTY 37 or TermiNet 300 terminals, will set the tab stops correctly (*tabs* (VII)).

Section *tty* (IV) discusses typewriter I/O more fully. Section *kl* (IV) discusses the console typewriter.

How to run a program; the Shell. When you have successfully logged into UNIX, a program called the Shell is listening to your terminal. The Shell reads typed-in lines, splits them up into a command name and arguments, and executes the command. A command is simply an executable program. The Shell looks first in your current directory (see next section) for a program with the given name, and if none is there, then in a system directory. There is nothing special about system-provided commands except that they are kept in a directory where the Shell can find them.

The command name is always the first word on an input line; it and its arguments are separated from one another by spaces.

When a program terminates, the Shell will ordinarily regain control and type a “%” at you to indicate that it is ready for another command.

The Shell has many other capabilities, which are described in detail in section *sh* (I).

The current directory. UNIX has a file system arranged in a hierarchy of directories. When the system administrator gave you a user name, he also created a directory for you (ordinarily with the same name as your user name). When you log in, any file name you type is by default in this directory. Since you are the owner of this directory, you have full permissions to read, write, alter, or destroy its contents. Permissions to have your will with other directories and files will have been granted or denied to you by their owners. As a matter of observed fact, few UNIX users protect their files from destruction, let alone perusal, by other users.

To change the current directory (but not the set of permissions you were endowed with at login) use *chdir* (I).

Path names. To refer to files not in the current directory, you must use a path name. Full path names begin with “/”, the name of the root directory of the whole file system. After the slash comes the name of each directory containing the next sub-directory (followed by a “/”) until finally the file name is reached. E.g.: */usr/lem/flex* refers to the file *flex* in the directory *lem*; *lem* is itself a subdirectory of *usr*; *usr* springs directly from the root directory.

If your current directory has subdirectories, the path names of files therein begin with the name of the sub-directory (no prefixed “/”).

Without important exception, a path name may be used anywhere a file name is required.

Important commands which modify the contents of files are *cp* (I), *mv* (I), and *rm* (I), which respectively copy, move (i.e. rename) and remove files. To find out the status of files or directories, use *ls* (I). See *mkdir* (I) for making directories; *rmdir* (I) for destroying them.

For a fuller discussion of the file system, see “The UNIX Time-Sharing System,” by the present authors, to appear in the Communications of the ACM; a version is also available from the same source as this manual. It may also be useful to glance through section II of this manual, which discusses system calls, even if you don’t intend to deal with the system at that level.

Writing a program. To enter the text of a source program into a UNIX file, use *ed* (I). The three principal languages in UNIX are assembly language (see *as* (I)), Fortran (see *fc* (I)), and C (see *cc* (I)). After the program text has been entered through the editor and written on a file, you can give the file to the appropriate language processor as an argument. The output of the language processor will be left on a file in the current directory named “a.out”. (If the output is precious, use *mv* to move it to a less exposed name soon.) If you wrote in assembly language, you will probably need to load the program with library subroutines; see *ld* (I). The other two language processors call the loader automatically.

When you have finally gone through this entire process without provoking any diagnostics, the resulting program can be run by giving its name to the Shell in response to the “%” prompt.

The next command you will need is *db* (I). As a debugger, *db* is better than average for assembly-language programs, marginally useful for C programs (when completed, *cdb* (I) will be a boon), and virtually useless for Fortran.

Your programs can receive arguments from the command line just as system programs do. See *exec* (II).

Text processing. Almost all text is entered through the editor. The commands most often used to write text on a terminal are: *cat*, *pr*, *roff*, *nroff*, and *troff*, all in section I.

The *cat* command simply dumps ASCII text on the terminal, with no processing at all. The *pr* command paginates the text, supplies headings, and has a facility for multi-column output. *Troff* and *nroff* are elaborate text formatting programs, and require careful forethought in entering both the text and the formatting commands into the input file. *Troff* drives a Graphic Systems phototypesetter; it was used to produce this manual. *Nroff* produces output on a typewriter terminal. *Roff* (I) is a somewhat less elaborate text formatting program, and requires somewhat less forethought.

Surprises. Certain commands provide inter-user communication. Even if you do not plan to use them, it would be well to learn something about them, because someone else may aim them at you.

To communicate with another user currently logged in, *write* (I) is used; *mail* (I) will leave a message whose presence will be announced to another user when he next logs in. The write-ups in the manual also suggest how to respond to the two commands if you are a target.

When you log in, a message-of-the-day may greet you before the first “%”.

TABLE OF CONTENTS

I. COMMANDS

ar	archive and library maintainer
as	assembler
cat	concatenate and print
cc	C compiler
cdb	C debugger
chdir	change working directory
chmod	change mode
chown	change owner
cmp	compare two files
comm	print lines common to two files
cp	copy
cref	make cross reference listing
date	print and set the date
db	debug
dc	desk calculator
dd	convert and copy a file
diff	differential file comparator
dsw	delete interactively
du	summarize disk usage
echo	echo arguments
ed	editor
eqn	typeset mathematics
exit	terminate command file
fc	fortran compiler
fed	edit associative memory for form letter
find	find files
form	form letter generator
goto	command transfer
grep	search a file for a pattern
if	conditional command
kill	do in an unwanted process
ld	link editor
ln	make a link
login	sign onto UNIX
lpr	on line print
ls	list contents of directory
mail	send mail to another user
man	run off section of UNIX manual
mesg	permit or deny messages
mkdir	make a directory
mv	move or rename a file
neqn	typeset mathematics on terminal
nice	run a command at low priority
nm	print name list
nohup	run a command immune to hangups
nroff	format text
od	octal dump
opr	off line print
passwd	set login password

pfe	. . . . .	print floating exception
pr	. . . . .	print file
prof	. . . . .	display profile data
ps	. . . . .	process status
pwd	. . . . .	working directory name
rew	. . . . .	rewind tape
rm	. . . . .	remove (unlink) files
rmdir	. . . . .	remove directory
roff	. . . . .	format text
sh	. . . . .	shell (command interpreter)
shift	. . . . .	adjust Shell arguments
size	. . . . .	size of an object file
sleep	. . . . .	suspend execution for an interval
sort	. . . . .	sort or merge files
spell	. . . . .	find spelling errors
split	. . . . .	split a file into pieces
strip	. . . . .	remove symbols and relocation bits
stty	. . . . .	set teletype options
sum	. . . . .	sum file
tee	. . . . .	pipe fitting
time	. . . . .	time a command
tp	. . . . .	manipulate DEctape and magtape
tr	. . . . .	transliterate
troff	. . . . .	format text
tss	. . . . .	interface to MH-TSS
tty	. . . . .	get typewriter name
typo	. . . . .	find possible typos
uniq	. . . . .	report repeated lines in a file
wait	. . . . .	await completion of process
wc	. . . . .	word count
who	. . . . .	who is on the system
write	. . . . .	write to another user

II. SYSTEM CALLS

intro	. . . . .	introduction to system calls
break	. . . . .	set program break
chdir	. . . . .	change working directory
chmod	. . . . .	change mode of file
chown	. . . . .	change owner
close	. . . . .	close a file
creat	. . . . .	create a new file
csw	. . . . .	read console switches
dup	. . . . .	duplicate an open file descriptor
exec	. . . . .	execute a file
exit	. . . . .	terminate process
fork	. . . . .	spawn new process
fstat	. . . . .	get status of open file
getgid	. . . . .	get group identifications
getuid	. . . . .	get user identifications
gtty	. . . . .	get typewriter status
indir	. . . . .	indirect system call
kill	. . . . .	send signal to a process

link	. . . . .	link to a file
mknod	. . . . .	make a directory or a special file
mount	. . . . .	mount file system
nice	. . . . .	set program priority
open	. . . . .	open for reading or writing
pipe	. . . . .	create a pipe
profil	. . . . .	execution time profile
read	. . . . .	read from file
seek	. . . . .	move read/write pointer
setgid	. . . . .	set process group ID
setuid	. . . . .	set process user ID
signal	. . . . .	catch or ignore signals
sleep	. . . . .	stop execution for interval
stat	. . . . .	get file status
stime	. . . . .	set time
stty	. . . . .	set mode of typewriter
sync	. . . . .	update super-block
time	. . . . .	get date and time
times	. . . . .	get process times
umount	. . . . .	dismount file system
unlink	. . . . .	remove directory entry
wait	. . . . .	wait for process to die
write	. . . . .	write on a file

III. SUBROUTINES

alloc	. . . . .	core allocator
atan	. . . . .	arc tangent function
atof	. . . . .	ascii to floating
crypt	. . . . .	password encoding
ctime	. . . . .	convert date and time to ASCII
ecvt	. . . . .	output conversion
exp	. . . . .	exponential function
floor	. . . . .	floor and ceiling functions
fptrap	. . . . .	floating point interpreter
gamma	. . . . .	log gamma function
getarg	. . . . .	get command arguments from Fortran
getc	. . . . .	buffered input
getchar	. . . . .	read character
getpw	. . . . .	get name from UID
hmul	. . . . .	high-order product
hypot	. . . . .	calculate hypotenuse
ierror	. . . . .	catch Fortran errors
ldiv	. . . . .	long division
locv	. . . . .	long output conversion
log	. . . . .	natural logarithm
monitor	. . . . .	prepare execution profile
nargs	. . . . .	argument count
nlist	. . . . .	get entries from name list
perror	. . . . .	system error messages
pow	. . . . .	floating exponentiation
printf	. . . . .	formatted print
putc	. . . . .	buffered output

putchar	. . . . .	write character
qsort	. . . . .	quicker sort
rand	. . . . .	random number generator
reset	. . . . .	execute non-local goto
setfil	. . . . .	specify Fortran file name
sin	. . . . .	sine, cosine
sqrt	. . . . .	square root function
ttyn	. . . . .	return name of current typewriter
vt	. . . . .	display (vt01) interface

IV. SPECIAL FILES

cat	. . . . .	phototypesetter interface
dc	. . . . .	DC-11 communications interface
dh	. . . . .	DH-11 communications multiplexer
dn	. . . . .	DN-11 ACU interface
dp	. . . . .	DP-11 201 data-phone interface
kl	. . . . .	KL-11 or DL-11 asynchronous interface
lp	. . . . .	line printer
mem	. . . . .	core memory
pc	. . . . .	PC-11 paper tape reader/punch
rf	. . . . .	RF11/RS11 fixed-head disk file
rk	. . . . .	RK-11/RK03 (or RK05) disk
rp	. . . . .	RP-11/RP03 moving-head disk
tc	. . . . .	TC-11/TU56 DECTape
tiu	. . . . .	Spider interface
tm	. . . . .	TM-11/TU-10 magtape interface
tty	. . . . .	general typewriter interface
vs	. . . . .	voice synthesizer interface
vt	. . . . .	11/20 (vt01) interface

V. FILE FORMATS AND CONVENTIONS

a.out	. . . . .	assembler and link editor output
ar	. . . . .	archive (library) file format
core	. . . . .	format of core image file
dir	. . . . .	format of directories
dump	. . . . .	incremental dump tape format
fs	. . . . .	format of file system volume
mtab	. . . . .	mounted file system table
passwd	. . . . .	password file
speak.m	. . . . .	voice synthesizer vocabulary
tp	. . . . .	DEC/mag tape formats
ttys	. . . . .	typewriter initialization data
utmp	. . . . .	user information
wtmp	. . . . .	user login history

VI. USER MAINTAINED PROGRAMS

apl	. . . . .	APL interpreter
azel	. . . . .	obtain satellite predictions
bas	. . . . .	basic
bj	. . . . .	the game of black jack

cal	. . . . .	print calendar
catsim	. . . . .	phototypesetter simulator
chess	. . . . .	the game of chess
col	. . . . .	filter reverse line feeds
cubic	. . . . .	three dimensional tic-tac-toe
factor	. . . . .	discover prime factors of a number
graf	. . . . .	draw graph on GSI terminal
gsi	. . . . .	interpret extended character set on GSI terminal
hyphen	. . . . .	find hyphenated words
ibm	. . . . .	submit off-line job to HO IBM 370
m6	. . . . .	general purpose macroprocessor
maze	. . . . .	generate a maze problem
moo	. . . . .	guessing game
npr	. . . . .	print file on Spider line-printer
plog	. . . . .	make a graph on the gsi terminal
plot	. . . . .	make a graph
ptx	. . . . .	permuted index
sfs	. . . . .	structured file scanner
sky	. . . . .	obtain ephemerides
sno	. . . . .	Snobol interpreter
speak	. . . . .	word to voice translator
spline	. . . . .	interpolate smooth curve
tmg	. . . . .	compiler-compiler
ttt	. . . . .	tic-tac-toe
wump	. . . . .	hunt the wumpus
yacc	. . . . .	yet another compiler-compiler

VII. USER MAINTAINED SUBROUTINES

ascii	. . . . .	map of ASCII character set
greek	. . . . .	graphics for extended TTY-37 type-box
tabs	. . . . .	set tab stops
tmheader	. . . . .	TM cover sheet
vs	. . . . .	voice synthesizer code

VIII. SYSTEM MAINTENANCE

20boot	. . . . .	install new 11/20 system
ac	. . . . .	login accounting
boot procedures	. . . . .	UNIX startup
check	. . . . .	file system consistency check
clri	. . . . .	clear i-node
df	. . . . .	disk free
dpd	. . . . .	spawn data phone daemon
dump	. . . . .	incremental file system dump
getty	. . . . .	set typewriter mode
glob	. . . . .	generate command arguments
init	. . . . .	process control initialization
lpd	. . . . .	line printer daemon
mkfs	. . . . .	construct a file system
mknod	. . . . .	build special file
mount	. . . . .	mount file system
msh	. . . . .	mini-shell

reloc	. . . . .	relocate object files
restor	. . . . .	incremental file system restore
sa	. . . . .	Shell accounting
su	. . . . .	become privileged user
sync	. . . . .	update the super block
umount	. . . . .	dismount file system
update	. . . . .	periodically update the super block

PERMUTED INDEX

20boot(VIII) install new 11/20 system
 vt(IV) 11/20 (vt01) interface
 dp(IV) DP-11 201 data-phone interface
 20boot(VIII) install new 11/20 system
 ibm(VI) submit off-line job to HO IBM 370
 ac(VIII) login accounting
 sa(VIII) Shell accounting
 dn(IV) DN-11 ACU interface
 ac(VIII) login accounting
 shift(I) adjust Shell arguments
 alloc(III) core allocator
 alloc(III) core allocator
 yacc(VI) yet another compiler-compiler
 mail(I) send mail to another user
 write(I) write to another user
 a.out(V) assembler and link editor output
 apl(VI) APL interpreter
 apl(VI) APL interpreter
 atan(III) arc tangent function
 ar(I) archive and library maintainer
 ar(V) archive (library) file format
 nargs(III) argument count
 getarg(III) get command arguments from Fortran
 echo(I) echo arguments
 glob(VIII) generate command arguments
 shift(I) adjust Shell arguments
 ar(I) archive and library maintainer
 ar(V) archive (library) file format
 ascii(VII) map of ASCII character set
 atof(III) ascii to floating
 ctime(III) convert date and time to ASCII
 ascii(VII) map of ASCII character set
 as(I) assembler
 a.out(V) assembler and link editor output
 as(I) assembler
 fed(I) edit associative memory for form letter
 kl(IV) KL-11 or DL-11 asynchronous interface
 nice(I) run a command at low priority
 atan(III) arc tangent function
 atof(III) ascii to floating
 wait(I) await completion of process
 azel(VI) obtain satellite predictions
 bas(VI) basic
 bas(VI) basic
 su(VIII) become privileged user
 strip(I) remove symbols and relocation bits
 bj(VI) the game of black jack
 bj(VI) the game of black jack
 sync(VIII) update the super block
 update(VIII) periodically update the super block
 boot procedures(VIII) UNIX startup

break(II) set program	break
	break(II) set program break
getc(III)	buffered input
putc(III)	buffered output
mknod(VIII)	build special file
cc(I)	C compiler
cdb(I)	C debugger
hypot(III)	calculate hypotenuse
dc(I) desk	calculator
cal(VI) print	calendar
indir(II) indirect system	call
intro(II) introduction to system	calls
	cal(VI) print calendar
ierror(III)	catch Fortran errors
signal(II)	catch or ignore signals
	cat(I) concatenate and print
	cat(IV) phototypesetter interface
	catsim(VI) phototypesetter simulator
	cc(I) C compiler
	cdb(I) C debugger
floor(III) floor and	ceiling functions
chmod(II)	change mode of file
chmod(I)	change mode
chown(I)	change owner
chown(II)	change owner
chdir(I)	change working directory
chdir(II)	change working directory
gsi(VI) interpret extended	character set on GSI terminal
ascii(VII) map of ASCII	character set
getchar(III) read	character
putchar(III) write	character
	chdir(I) change working directory
	chdir(II) change working directory
check(VIII) file system consistency	check
	check(VIII) file system consistency check
chess(VI) the game of	chess
	chess(VI) the game of chess
	chmod(I) change mode
	chmod(II) change mode of file
	chown(I) change owner
	chown(II) change owner
clri(VIII)	clear i-node
close(II)	close a file
	close(II) close a file
	clri(VIII) clear i-node
	cmp(I) compare two files
vs(VII) voice synthesizer	code
	col(VI) filter reverse line feeds
getarg(III) get	command arguments from Fortran
glob(VIII) generate	command arguments
nice(I) run a	command at low priority
exit(I) terminate	command file
nohup(I) run a	command immune to hangups

sh(I) shell	(command interpreter)
goto(I)	command transfer
if(I) conditional	command
time(I) time a	command
comm(I) print lines	comm(I) print lines common to two files
	common to two files
dc(IV) DC-11	communications interface
dh(IV) DH-11	communications multiplexer
diff(I) differential file	comparator
	cmp(I) compare two files
	cc(I) C compiler
	tmg(VI) compiler-compiler
yacc(VI) yet another	compiler-compiler
	fc(I) fortran compiler
	wait(I) await completion of process
	cat(I) concatenate and print
	if(I) conditional command
check(VIII) file system	consistency check
	csw(II) read console switches
	mkfs(VIII) construct a file system
	ls(I) list contents of directory
init(VIII) process	control initialization
	ecvt(III) output conversion
locv(III) long output	conversion
	dd(I) convert and copy a file
	ctime(III) convert date and time to ASCII
dd(I) convert and	copy a file
	cp(I) copy
	alloc(III) core allocator
core(V) format of	core image file
	mem(IV) core memory
	core(V) format of core image file
	sin(III) sine, cosine
nargs(III) argument	count
	wc(I) word count
tmheader(VII) TM	cover sheet
	cp(I) copy
	creat(II) create a new file
	pipe(II) create a pipe
	creat(II) create a new file
	cref(I) make cross reference listing
cref(I) make	cross reference listing
	crypt(III) password encoding
	csw(II) read console switches
	ctime(III) convert date and time to ASCII
	cubic(VI) three dimensional tic-tac-toe
ttyn(III) return name of	current typewriter
spline(VI) interpolate smooth	curve
dpd(VIII) spawn data phone	daemon
lpd(VIII) line printer	daemon
	dpd(VIII) spawn data phone daemon
	dp(IV) DP-11 201 data-phone interface
prof(I) display profile	data

ttys(V) typewriter initialization data
 ctime(III) convert date and time to ASCII
 time(II) get date and time
 date(I) print and set the date
 date(I) print and set the date
 db(I) debug
 dc(IV) DC-11 communications interface
 dc(I) desk calculator
 dc(IV) DC-11 communications interface
 dd(I) convert and copy a file
 db(I) debug
 cdb(I) C debugger
 tp(V) DEC/mag tape formats
 tp(I) manipulate DECTape and magtape
 tc(IV) TC-11/TU56 DECTape
 dsw(I) delete interactively
 mesg(I) permit or deny messages
 dup(II) duplicate an open file descriptor
 dc(I) desk calculator
 df(VIII) disk free
 dh(IV) DH-11 communications multiplexer
 dh(IV) DH-11 communications multiplexer
 wait(II) wait for process to die
 diff(I) differential file comparator
 diff(I) differential file comparator
 cubic(VI) three dimensional tic-tac-toe
 dir(V) format of directories
 unlink(II) remove directory entry
 pwd(I) working directory name
 mknod(II) make a directory or a special file
 chdir(I) change working directory
 chdir(II) change working directory
 ls(I) list contents of directory
 mkdir(I) make a directory
 rmdir(I) remove directory
 dir(V) format of directories
 factor(VI) discover prime factors of a number
 rf(IV) RF11/RS11 fixed-head disk file
 df(VIII) disk free
 du(I) summarize disk usage
 rk(IV) RK-11/RK03 (or RK05) disk
 rp(IV) RP-11/RP03 moving-head disk
 umount(II) dismount file system
 umount(VIII) dismount file system
 prof(I) display profile data
 vt(III) display (vt01) interface
 ldiv(III) long division
 kl(IV) KL-11 or DL-11 asynchronous interface
 dn(IV) DN-11 ACU interface
 dn(IV) DN-11 ACU interface
 kill(I) do in an unwanted process
 dp(IV) DP-11 201 data-phone interface
 dpd(VIII) spawn data phone daemon

dp(IV) DP-11 201 data-phone interface
 graf(VI) draw graph on GSI terminal
 dsw(I) delete interactively
 du(I) summarize disk usage
 dump(V) incremental dump tape format
 dump(VIII) incremental file system dump
 od(I) octal dump
 dump(V) incremental dump tape format
 dump(VIII) incremental file system dump
 dup(II) duplicate an open file descriptor
 dup(II) duplicate an open file descriptor
 echo(I) echo arguments
 echo(I) echo arguments
 ecvt(III) output conversion
 ed(I) editor
 fed(I) edit associative memory for form letter
 a.out(V) assembler and link editor output
 ed(I) editor
 ld(I) link editor
 crypt(III) password encoding
 nlist(III) get entries from name list
 unlink(II) remove directory entry
 sky(VI) obtain ephemerides
 eqn(I) typeset mathematics
 error messages
 perror(III) system errors
 ierror(III) catch Fortran errors
 spell(I) find spelling errors
 pfe(I) print floating exception
 exec(II) execute a file
 exec(II) execute a file
 reset(III) execute non-local goto
 sleep(I) suspend execution for an interval
 sleep(II) stop execution for interval
 monitor(III) prepare execution profile
 profil(II) execution time profile
 exit(I) terminate command file
 exit(II) terminate process
 exp(III) exponential function
 exp(III) exponential function
 pow(III) floating exponentiation
 gsi(VI) interpret extended character set on GSI terminal
 greek(VII) graphics for extended TTY-37 type-box
 factor(VI) discover prime factors of a number
 factor(VI) discover prime factors of a number
 fc(I) fortran compiler
 fed(I) edit associative memory for form letter
 col(VI) filter reverse line feeds
 diff(I) differential file comparator
 dup(II) duplicate an open file descriptor
 grep(I) search a file for a pattern
 ar(V) archive (library) file format
 split(I) split a file into pieces
 setfil(III) specify Fortran file name

npr(VI)	print	file on Spider line-printer
sfs(VI)	structured	file scanner
stat(II)	get	file status
check(VIII)		file system consistency check
dump(VIII)	incremental	file system dump
restor(VIII)	incremental	file system restore
mtab(V)	mounted	file system table
fs(V)	format of	file system volume
mkfs(VIII)	construct a	file system
mount(II)	mount	file system
mount(VIII)	mount	file system
umount(II)	dismount	file system
umount(VIII)	dismount	file system
chmod(II)	change mode of	file
	close(II)	close a file
core(V)	format of core image	file
creat(II)	create a new	file
dd(I)	convert and copy a	file
	exec(II)	execute a file
exit(I)	terminate command	file
fstat(II)	get status of open	file
	link(II)	link to a file
mknod(II)	make a directory or a special	file
mknod(VIII)	build special	file
mv(I)	move or rename a	file
passwd(V)	password	file
	pr(I)	print file
	read(II)	read from file
rf(IV)	RF11/RS11 fixed-head disk	file
	cmp(I)	compare two files
comm(I)	print lines common to two	files
	find(I)	find files
	size(I)	size of an object file
reloc(VIII)	relocate object	files
rm(I)	remove (unlink)	files
sort(I)	sort or merge	files
	sum(I)	sum file
uniq(I)	report repeated lines in a	file
	write(II)	write on a file
	col(VI)	filter reverse line feeds
	find(I)	find files
	hyphen(VI)	find hyphenated words
	typo(I)	find possible typos
	spell(I)	find spelling errors
	find(I)	find files
	tee(I)	pipe fitting
rf(IV)	RF11/RS11	fixed-head disk file
	pfe(I)	print floating exception
	pow(III)	floating exponentiation
	fptrap(III)	floating point interpreter
	atof(III)	ascii to floating
	floor(III)	floor and ceiling functions
	floor(III)	floor and ceiling functions

	fork(II)	spawn new process
	form(I)	form letter generator
fed(I)	edit associative memory for	form letter
	core(V)	format of core image file
	dir(V)	format of directories
	fs(V)	format of file system volume
	nroff(I)	format text
	roff(I)	format text
	troff(I)	format text
	ar(V)	archive (library) file
dump(V)	incremental dump tape	format
	tp(V)	DEC/mag tape
	printf(III)	formatted print
		form(I) form letter generator
	fc(I)	fortran compiler
	ierror(III)	catch Fortran errors
	setfil(III)	specify Fortran file name
getarg(III)	get command arguments from	Fortran
	fptrap(III)	floating point interpreter
	df(VIII)	disk free
	read(II)	read from file
getarg(III)	get command arguments	from Fortran
	nlist(III)	get entries from name list
	getpw(III)	get name from UID
	fstat(II)	get status of open file
	fs(V)	format of file system volume
	atan(III)	arc tangent function
	exp(III)	exponential function
	gamma(III)	log gamma function
floor(III)	floor and ceiling	functions
	sqrt(III)	square root function
	bj(VI)	the game of black jack
	chess(VI)	the game of chess
	moo(VI)	guessing game
	gamma(III)	log gamma function
		gamma(III) log gamma function
	m6(VI)	general purpose macroprocessor
	tty(IV)	general typewriter interface
	maze(VI)	generate a maze problem
	glob(VIII)	generate command arguments
	form(I)	form letter generator
rand(III)	random number	generator
	getarg(III)	get command arguments from Fortran
	time(II)	get date and time
	nlist(III)	get entries from name list
	stat(II)	get file status
	getgid(II)	get group identifications
	getpw(III)	get name from UID
	times(II)	get process times
	fstat(II)	get status of open file
	tty(I)	get typewriter name
	gtty(II)	get typewriter status
	getuid(II)	get user identifications

	getarg(III) get command arguments from Fortran
	getchar(III) read character
	getc(III) buffered input
	getgid(II) get group identifications
	getpw(III) get name from UID
	getty(VIII) set typewriter mode
	getuid(II) get user identifications
	glob(VIII) generate command arguments
	goto(I) command transfer
reset(III) execute non-local	goto
	graf(VI) draw graph on GSI terminal
graf(VI) draw	graph on GSI terminal
plog(VI) make a	graph on the gsi terminal
greek(VII)	graphics for extended TTY-37 type-box
plot(VI) make a	graph
	greek(VII) graphics for extended TTY-37 type-box
	grep(I) search a file for a pattern
	group identifications
getgid(II) get	group ID
setgid(II) set process	GSI terminal
graf(VI) draw graph on	GSI terminal
gsi(VI) interpret extended character set on	gsi terminal
plog(VI) make a graph on the	gsi(VI) interpret extended character set on GSI terminal
	gtty(II) get typewriter status
	moo(VI) guessing game
nohup(I) run a command immune to	hangups
	hmul(III) high-order product
wtmp(V) user login	history
	hmul(III) high-order product
ibm(VI) submit off-line job to	HO IBM 370
wump(VI)	hunt the wumpus
hyphen(VI) find	hyphenated words
	hyphen(VI) find hyphenated words
hypot(III) calculate	hypotenuse
	hypot(III) calculate hypotenuse
ibm(VI) submit off-line job to HO	IBM 370
	ibm(VI) submit off-line job to HO IBM 370
getgid(II) get group	identifications
getuid(II) get user	identifications
setgid(II) set process group	ID
setuid(II) set process user	ID
	ierror(III) catch Fortran errors
	if(I) conditional command
signal(II) catch or	ignore signals
core(V) format of core	image file
nohup(I) run a command	immune to hangups
uniq(I) report repeated lines	in a file
kill(I) do	in an unwanted process
dump(V)	incremental dump tape format
dump(VIII)	incremental file system dump
restor(VIII)	incremental file system restore
ptx(VI) permuted	index
indir(II)	indirect system call

	indir(II) indirect system call
utmp(V) user	information
ttys(V) typewriter	initialization data
init(VIII) process control	initialization
	init(VIII) process control initialization
clri(VIII) clear	i-node
getc(III) buffered	input
20boot(VIII)	install new 11/20 system
dsw(I) delete	interactively
tss(I)	interface to MH-TSS
cat(IV) phototypesetter	interface
dc(IV) DC-11 communications	interface
dn(IV) DN-11 ACU	interface
dp(IV) DP-11 201 data-phone	interface
kl(IV) KL-11 or DL-11 asynchronous	interface
tiu(IV) Spider	interface
tm(IV) TM-11/TU-10 magtape	interface
tty(IV) general typewriter	interface
vs(IV) voice synthesizer	interface
vt(III) display (vt01)	interface
vt(IV) 11/20 (vt01)	interface
spline(VI)	interpolate smooth curve
gsi(VI)	interpret extended character set on GSI terminal
apl(VI) APL	interpreter
fptrap(III) floating point	interpreter
sh(I) shell (command	interpreter)
sno(VI) Snobol	interpreter
sleep(I) suspend execution for an	interval
sleep(II) stop execution for	interval
split(I) split a file	into pieces
intro(II)	introduction to system calls
	intro(II) introduction to system calls
bj(VI) the game of black	jack
ibm(VI) submit off-line	job to HO IBM 370
	kill(I) do in an unwanted process
	kill(II) send signal to a process
kl(IV)	KL-11 or DL-11 asynchronous interface
	kl(IV) KL-11 or DL-11 asynchronous interface
	ld(I) link editor
	ldiv(III) long division
form(I) form	letter generator
fed(I) edit associative memory for form	letter
ar(V) archive	(library) file format
ar(I) archive and	library maintainer
col(VI) filter reverse	line feeds
lpd(VIII)	line printer daemon
lp(IV)	line printer
lpr(I) on	line print
opr(I) off	line print
npr(VI) print file on Spider	line-printer
comm(I) print	lines common to two files
uniq(I) report repeated	lines in a file
a.out(V) assembler and	link editor output

ld(I)	link editor
link(II)	link to a file
	link(II) link to a file
ln(I)	make a link
ls(I)	list contents of directory
cref(I)	make cross reference listing
nlist(III)	get entries from name list
nm(I)	print name list
	ln(I) make a link
	locv(III) long output conversion
gamma(III)	log gamma function
log(III) natural	logarithm
	log(III) natural logarithm
ac(VIII)	login accounting
wtmp(V) user	login history
passwd(I) set	login password
	login(I) sign onto UNIX
ldiv(III)	long division
locv(III)	long output conversion
nice(I)	run a command at low priority
	lpd(VIII) line printer daemon
	lp(IV) line printer
	lpr(I) on line print
	ls(I) list contents of directory
	m6(VI) general purpose macroprocessor
m6(VI) general purpose	macroprocessor
tm(IV) TM-11/TU-10	magtape interface
tp(I) manipulate DECtape and	magtape
mail(I) send	mail to another user
	mail(I) send mail to another user
ar(I) archive and library	maintainer
mknod(II)	make a directory or a special file
mkdir(I)	make a directory
plog(VI)	make a graph on the gsi terminal
plot(VI)	make a graph
ln(I)	make a link
cref(I)	make cross reference listing
	man(I) run off section of UNIX manual
tp(I)	manipulate DECtape and magtape
man(I) run off section of UNIX	manual
ascii(VII)	map of ASCII character set
neqn(I) typeset	mathematics on terminal
eqn(I) typeset	mathematics
maze(VI) generate a	maze problem
	maze(VI) generate a maze problem
	mem(IV) core memory
fed(I) edit associative	memory for form letter
mem(IV) core	memory
sort(I) sort or	merge files
	mesg(I) permit or deny messages
mesg(I) permit or deny	messages
perror(III) system error	messages
tss(I) interface to	MH-TSS

msh(VIII)	mini-shell
	mkdir(I) make a directory
	mkfs(VIII) construct a file system
	mknod(II) make a directory or a special file
	mknod(VIII) build special file
chmod(II) change	mode of file
stty(II) set	mode of typewriter
chmod(I) change	mode
getty(VIII) set typewriter	mode
	monitor(III) prepare execution profile
	moo(VI) guessing game
mount(II)	mount file system
mount(VIII)	mount file system
mtab(V)	mounted file system table
	mount(II) mount file system
	mount(VIII) mount file system
mv(I)	move or rename a file
seek(II)	move read/write pointer
rp(IV) RP-11/RP03	moving-head disk
	msh(VIII) mini-shell
	mtab(V) mounted file system table
dh(IV) DH-11 communications	multiplexer
	mv(I) move or rename a file
getpw(III) get	name from UID
nlist(III) get entries from	name list
nm(I) print	name list
ttyn(III) return	name of current typewriter
pwd(I) working directory	name
setfil(III) specify Fortran file	name
tty(I) get typewriter	name
	nargs(III) argument count
log(III)	natural logarithm
	neqn(I) typeset mathematics on terminal
20boot(VIII) install	new 11/20 system
creat(II) create a	new file
fork(II) spawn	new process
	nice(I) run a command at low priority
	nice(II) set program priority
	nlist(III) get entries from name list
	nm(I) print name list
	nohup(I) run a command immune to hangups
reset(III) execute	non-local goto
	npr(VI) print file on Spider line-printer
	nroff(I) format text
rand(III) random	number generator
factor(VI) discover prime factors of a	number
size(I) size of an	object file
reloc(VIII) relocate	object files
sky(VI)	obtain ephemerides
azel(VI)	obtain satellite predictions
od(I)	octal dump
	od(I) octal dump
opr(I)	off line print

man(I)	run	off section of UNIX manual
ibm(VI)	submit	off-line job to HO IBM 370
login(I)	sign	onto UNIX
dup(II)	duplicate an	open file descriptor
fstat(II)	get status of	open file
	open(II)	open for reading or writing
		open(II) open for reading or writing
	opr(I)	off line print
stty(I)	set teletype	options
rk(IV)	RK-11/RK03	(or RK05) disk
	ecvt(III)	output conversion
	locv(III)	long output conversion
a.out(V)	assembler and link editor	output
	putc(III)	buffered output
	chown(I)	change owner
	chown(II)	change owner
	pc(IV)	PC-11 paper tape reader/punch
		passwd(I) set login password
		passwd(V) password file
	crypt(III)	password encoding
	passwd(V)	password file
	passwd(I)	set login password
grep(I)	search a file for a	pattern
	pc(IV)	PC-11 paper tape reader/punch
		pc(IV) PC-11 paper tape reader/punch
	update(VIII)	periodically update the super block
	mesg(I)	permit or deny messages
	ptx(VI)	permuted index
		perror(III) system error messages
		pfe(I) print floating exception
dpd(VIII)	spawn data	phone daemon
	cat(IV)	phototypesetter interface
	catsim(VI)	phototypesetter simulator
split(I)	split a file into	pieces
	tee(I)	pipe fitting
		pipe(II) create a pipe
	pipe(II)	create a pipe
		plog(VI) make a graph on the gsi terminal
		plot(VI) make a graph
	fptrap(III)	floating point interpreter
seek(II)	move read/write	pointer
	typo(I)	find possible typos
		pow(III) floating exponentiation
azel(VI)	obtain satellite	predictions
	monitor(III)	prepare execution profile
		pr(I) print file
factor(VI)	discover	prime factors of a number
	date(I)	print and set the date
	cal(VI)	print calendar
	npr(VI)	print file on Spider line-printer
		pr(I) print file
		pfe(I) print floating exception
	comm(I)	print lines common to two files

nm(I)	print name list
cat(I)	concatenate and print
lpd(VIII)	line printer daemon
lp(IV)	line printer
	printf(III) formatted print
lpr(I)	on line print
opr(I)	off line print
printf(III)	formatted print
nice(I)	run a command at low priority
nice(II)	set program priority
su(VIII)	become privileged user
maze(VI)	generate a maze problem
	boot procedures(VIII) UNIX startup
init(VIII)	process control initialization
setgid(II)	set process group ID
ps(I)	process status
times(II)	get process times
wait(II)	wait for process to die
setuid(II)	set process user ID
exit(II)	terminate process
fork(II)	spawn new process
kill(I)	do in an unwanted process
kill(II)	send signal to a process
wait(I)	await completion of process
hmul(III)	high-order product
	prof(I) display profile data
prof(I)	display profile data
monitor(III)	prepare execution profile
profil(II)	execution time profile
	profil(II) execution time profile
break(II)	set program break
nice(II)	set program priority
	ps(I) process status
	ptx(VI) permuted index
m6(VI)	general purpose macroprocessor
	putchar(III) write character
	putc(III) buffered output
	pwd(I) working directory name
	qsort(III) quicker sort
qsort(III)	quicker sort
	rand(III) random number generator
rand(III)	random number generator
getchar(III)	read character
csw(II)	read console switches
read(II)	read from file
pc(IV)	PC-11 paper tape reader/punch
	read(II) read from file
open(II)	open for reading or writing
seek(II)	move read/write pointer
cref(I)	make cross reference listing
reloc(VIII)	relocate object files
strip(I)	remove symbols and relocation bits
	reloc(VIII) relocate object files

unlink(II) remove directory entry
 rmdir(I) remove directory
 strip(I) remove symbols and relocation bits
 rm(I) remove (unlink) files
 mv(I) move or rename a file
 uniq(I) report repeated lines in a file
 uniq(I) report repeated lines in a file
 reset(III) execute non-local goto
 restor(VIII) incremental file system restore
 restor(VIII) incremental file system restore
 ttyn(III) return name of current typewriter
 col(VI) filter reverse line feeds
 rew(I) rewind tape
 rew(I) rewind tape
 rf(IV) RF11/RS11 fixed-head disk file
 rf(IV) RF11/RS11 fixed-head disk file
 rk(IV) RK-11/RK03 (or RK05) disk
 rk(IV) RK-11/RK03 (or RK05) disk
 rk(IV) RK-11/RK03 (or RK05) disk
 rmdir(I) remove directory
 rm(I) remove (unlink) files
 roff(I) format text
 sqrt(III) square root function
 rp(IV) RP-11/RP03 moving-head disk
 rp(IV) RP-11/RP03 moving-head disk
 nice(I) run a command at low priority
 nohup(I) run a command immune to hangsups
 man(I) run off section of UNIX manual
 azel(VI) obtain satellite predictions
 sa(VIII) Shell accounting
 sfs(VI) structured file scanner
 grep(I) search a file for a pattern
 man(I) run off section of UNIX manual
 seek(II) move read/write pointer
 mail(I) send mail to another user
 kill(II) send signal to a process
 passwd(I) set login password
 stty(II) set mode of typewriter
 gsi(VI) interpret extended character set on GSI terminal
 setgid(II) set process group ID
 setuid(II) set process user ID
 break(II) set program break
 nice(II) set program priority
 tabs(VII) set tab stops
 stty(I) set teletype options
 date(I) print and set the date
 stime(II) set time
 getty(VIII) set typewriter mode
 ascii(VII) map of ASCII character set
 setfil(III) specify Fortran file name
 setgid(II) set process group ID
 setuid(II) set process user ID
 sfs(VI) structured file scanner

tmheader(VII)	TM cover sheet
sa(VIII)	Shell accounting
shift(I)	adjust Shell arguments
sh(I)	shell (command interpreter)
sh(I)	shell (command interpreter)
shift(I)	adjust Shell arguments
login(I)	sign onto UNIX
kill(II)	send signal to a process
signal(II)	catch or ignore signals
signal(II)	catch or ignore signals
catsim(VI)	phototypesetter simulator
sin(III)	sine, cosine
sin(III)	sine, cosine
size(I)	size of an object file
size(I)	size of an object file
sky(VI)	obtain ephemerides
sleep(I)	suspend execution for an interval
sleep(II)	stop execution for interval
spline(VI)	interpolate smooth curve
sno(VI)	Snobol interpreter
sno(VI)	Snobol interpreter
sort(I)	sort or merge files
sort(I)	sort or merge files
qsort(III)	quicker sort
dpd(VIII)	spawn data phone daemon
fork(II)	spawn new process
speak.m(V)	voice synthesizer vocabulary
speak(VI)	word to voice translator
mknod(II)	make a directory or a special file
mknod(VIII)	build special file
setfil(III)	specify Fortran file name
spell(I)	find spelling errors
spell(I)	find spelling errors
tiu(IV)	Spider interface
npr(VI)	print file on Spider line-printer
spline(VI)	interpolate smooth curve
split(I)	split a file into pieces
split(I)	split a file into pieces
sqrt(III)	square root function
sqrt(III)	square root function
boot procedures(VIII)	UNIX startup
stat(II)	get file status
fstat(II)	get status of open file
gtty(II)	get typewriter status
ps(I)	process status
stat(II)	get file status
stime(II)	set time
sleep(II)	stop execution for interval
tabs(VII)	set tab stops
strip(I)	remove symbols and relocation bits
sfs(VI)	structured file scanner
stty(I)	set teletype options
stty(II)	set mode of typewriter

ibm(VI)	submit off-line job to HO IBM 370
sum(I)	sum file
	sum(I) sum file
du(I)	summarize disk usage
sync(VIII)	update the super block
update(VIII)	periodically update the super block
	sync(II) update super-block
	sleep(I) suspend execution for an interval
	su(VIII) become privileged user
csw(II)	read console switches
strip(I)	remove symbols and relocation bits
	sync(II) update super-block
	sync(VIII) update the super block
vs(VII)	voice synthesizer code
vs(IV)	voice synthesizer interface
speak.m(V)	voice synthesizer vocabulary
indir(II)	indirect system call
intro(II)	introduction to system calls
	check(VIII) file system consistency check
dump(VIII)	incremental file system dump
	perror(III) system error messages
restor(VIII)	incremental file system restore
mtab(V)	mounted file system table
fs(V)	format of file system volume
20boot(VIII)	install new 11/20 system
mkfs(VIII)	construct a file system
mount(II)	mount file system
mount(VIII)	mount file system
umount(II)	dismount file system
umount(VIII)	dismount file system
who(I)	who is on the system
	tabs(VII) set tab stops
mtab(V)	mounted file system table
	atan(III) arc tangent function
dump(V)	incremental dump tape format
tp(V)	DEC/mag tape formats
pc(IV)	PC-11 paper tape reader/punch
rew(I)	rewind tape
tc(IV)	TC-11/TU56 DECtape
	tc(IV) TC-11/TU56 DECtape
	tee(I) pipe fitting
stty(I)	set teletype options
graf(VI)	draw graph on GSI terminal
interpret	extended character set on GSI terminal...gsi(VI)
neqn(I)	typeset mathematics on terminal
plog(VI)	make a graph on the gsi terminal
	exit(I) terminate command file
	exit(II) terminate process
nroff(I)	format text
roff(I)	format text
troff(I)	format text
cubic(VI)	three dimensional tic-tac-toe

cubic(VI) three dimensional	tic-tac-toe
ttt(VI)	tic-tac-toe
time(I)	time a command
profil(II) execution	time profile
ctime(III) convert date and	time to ASCII
	time(I) time a command
	time(II) get date and time
	times(II) get process times
stime(II) set	time
times(II) get process	times
time(II) get date and	time
	tiu(IV) Spider interface
tmheader(VII)	TM cover sheet
tm(IV)	TM-11/TU-10 magtape interface
	tmg(VI) compiler-compiler
	tmheader(VII) TM cover sheet
	tm(IV) TM-11/TU-10 magtape interface
	tp(I) manipulate DECTape and magtape
	tp(V) DEC/mag tape formats
goto(I) command	transfer
speak(VI) word to voice	translator
tr(I)	transliterate
	tr(I) transliterate
	troff(I) format text
	tss(I) interface to MH-TSS
	ttt(VI) tic-tac-toe
greek(VII) graphics for extended	TTY-37 type-box
	tty(I) get typewriter name
	tty(IV) general typewriter interface
	ttyn(III) return name of current typewriter
	ttys(V) typewriter initialization data
cmp(I) compare	two files
comm(I) print lines common to	two files
greek(VII) graphics for extended	TTY-37 type-box
	neqn(I) typeset mathematics on terminal
	eqn(I) typeset mathematics
	ttys(V) typewriter initialization data
tty(IV) general	typewriter interface
getty(VIII) set	typewriter mode
tty(I) get	typewriter name
gty(II) get	typewriter status
stty(II) set mode of	typewriter
ttyn(III) return name of current	typewriter
	typo(I) find possible typos
typo(I) find possible	typos
getpw(III) get name from	UID
	umount(II) dismount file system
	umount(VIII) dismount file system
	uniq(I) report repeated lines in a file
man(I) run off section of	UNIX manual
boot procedures(VIII)	UNIX startup
login(I) sign onto	UNIX
rm(I) remove	(unlink) files

	unlink(II)	remove directory entry
kill(I)	do in an	unwanted process
	sync(II)	update super-block
	sync(VIII)	update the super block
update(VIII)	periodically	update the super block
	update(VIII)	periodically update the super block
du(I)	summarize disk	usage
	getuid(II)	get user identifications
setuid(II)	set process	user ID
	utmp(V)	user information
	wtmp(V)	user login history
mail(I)	send mail to another	user
su(VIII)	become privileged	user
write(I)	write to another	user
	utmp(V)	user information
speak.m(V)	voice synthesizer	vocabulary
	vs(VII)	voice synthesizer code
	vs(IV)	voice synthesizer interface
	speak.m(V)	voice synthesizer vocabulary
	speak(VI)	word to voice translator
fs(V)	format of file system	volume
	vs(IV)	voice synthesizer interface
	vs(VII)	voice synthesizer code
vt(III)	display	(vt01) interface
vt(IV)	11/20	(vt01) interface
	vt(III)	display (vt01) interface
	vt(IV)	11/20 (vt01) interface
	wait(II)	wait for process to die
	wait(I)	await completion of process
	wait(II)	wait for process to die
	wc(I)	word count
	who(I)	who is on the system
	who(I)	who is on the system
	wc(I)	word count
	speak(VI)	word to voice translator
hyphen(VI)	find hyphenated	words
	pwd(I)	working directory name
chdir(I)	change	working directory
chdir(II)	change	working directory
putchar(III)		write character
	write(II)	write on a file
	write(I)	write to another user
	write(I)	write to another user
	write(II)	write on a file
open(II)	open for reading or	writing
	wtmp(V)	user login history
wump(VI)	hunt the	wumpus
	wump(VI)	hunt the wumpus
	yacc(VI)	yet another compiler-compiler
	yacc(VI)	yet another compiler-compiler