# CSSE3100 Crib Sheet

## Exam Format

The confirmed format of the exam is:

- `Q1` weakest precondition reasoning.
- `Q2` method specification and loop invariants.
- `Q3` recursion and termination metrics.
- `Q4` classes and data structures.
- `Q5` lemmas and functional programming

This section will be removed before the exam

## Question 1

### Predicate Logic

$A \wedge (A \vee B) \equiv A \equiv A \vee (A \wedge B)$ (A.6)
$A \wedge (B \vee C) \equiv (A \wedge B) \vee (A \wedge C)$ (A.7)
$A \vee (B \wedge C) \equiv (A \vee B) \wedge (A \vee C)$ (A.8)
$\neg(A \wedge B) \equiv \neg A \vee \neg B$ (A.18)
$\neg(A \vee B) \equiv \neg A \wedge \neg B$ (A.19)
$A \vee (\neg A \wedge B) \equiv A \vee B$ (A.20)
$A \wedge (\neg A \vee B) \equiv A \wedge B$ (A.21)
$A \Rightarrow B \equiv \neg A \vee B$ (A.22)
$A \Rightarrow B \equiv \neg(A \wedge \neg B)$ (A.24)
$\neg(A \Rightarrow B) \equiv A \wedge \neg B$ (A.25)
$A \Rightarrow B \equiv \neg B \Rightarrow \neg A$ (A.26)
$C \Rightarrow (A \wedge B) \equiv (C \Rightarrow A) \wedge (C \Rightarrow B)$ (A.33)
$(A \vee B) \Rightarrow C \equiv (A \Rightarrow C) \wedge (B \Rightarrow C)$ (A.34)
$C \Rightarrow (A \vee B) \equiv (C \Rightarrow A) \vee (C \Rightarrow B)$ (A.35)
$(A \wedge B) \Rightarrow C \equiv (A \Rightarrow C) \vee (B \Rightarrow C)$ (A.36)
$A \Rightarrow (B \Rightarrow C) \equiv (A \wedge B) \Rightarrow C \equiv B \Rightarrow (A \Rightarrow C)$ (A.37)
$(A \Rightarrow B) \wedge (\neg A \Rightarrow C) \equiv (A \wedge B) \vee (\neg A \wedge C)$ (A.38)
$(\forall x \text{ s.t. } x = E \Rightarrow A) \equiv A[x \backslash E] \equiv (\exists x \text{ s.t. } x = E \wedge A)$ (A.56)
$\forall x :: A \wedge B = (\forall x :: A) \wedge (\forall x :: B)$ (A.65)
$\forall x :: A = A$ provided $x$ not free in $A$ (A.74)

### Rules to know

### Basic Function

```
method MyMethod(x: int) returns (y: int)
    requires x == 10
    ensures y >= 25
{
    {x == 10}
    {x + 3 + 12 == 25}
    var a := x + 3;
    {a + 12 == 25}
    var b := 12;
    {a + b == 25}
    y := a + b;
    {y >= 25}
}
```

### Loops

```
{J}
while B
        invariant J
{
        {B && J}
        ...
        {J}
}
{J && !B}
```

```
{y >= 4 && z >= x}
while z < 0
        invariant y >= 4 && z >= x
{
        {z < 0 && y >= 4 && z >= x}
        {y >= 4 && z + y >= x}
        z := z + y;
        {y >= 4 && z >= x}
}
{z >= 0 && y >= 4 && z >= x}
```

### Arrays

```
var a := new string[20];
# Type of a is array<string>
var m := new bool[3, 10];
# Type of m is array2<bool>

idk what else to put here
```

```
method LinearSearch<T>(a: array<T>, P: T -> bool)
returns (n: int)
ensures 0 <= n <= a.Length
ensures n == a.Length || P(a[n])
ensures n == a.Length ==>
forall i :: 0 <= i < a.Length ==> !P(a[i])
{
n := 0;
while n != a.Length
        invariant 0 <= n <= a.Length
        invariant forall i :: 0 <= i < n ==>
                                !P(a[i])
{ 0 <= n < a.Length &&
(!P(a[n]) ==> (forall i :: 0 <= i < n ==>
                        !P(a[i]))
                                && !P(a[n])) }
{ (P(a[n]) ==> 0 <= n <= a.Length &&
(n == a.Length || P(a[n])) &&
(n == a.Length ==>
forall i :: 0 <= i < a.Length ==> !P(a[i]))) &&
(!P(a[n]) ==> (forall i :: 0 <= i < n ==>
                        !P(a[i])) && !P(a[n])) }
if (P(a[n])) {
        return;
}
{ (forall i :: 0 <= i < n ==> !P(a[i])) (A.56)
&& (forall i :: i == n ==> !P(a[i])) } (A.65)
{ forall i :: (0 <= i < n ==> !P(a[i])) &&
                        (i == n ==>
                        !P(a[i])) } (A.34)
{ forall i :: 0 <= i < n || i == n ==> !P(a[i])}
{ forall i :: 0 <= i < n + 1 ==> !P(a[i]) }
n := n + 1;
{ forall i :: 0 <= i < n ==> !P(a[i]) }
```

### Methods

```
wp(t := M(E), Q )
  = P[x \backslash E]
    &&  forall y' ::
      R[x,y \backslash E, y']
        ==> Q[t \backslash y']
```

```
method Triple(x: int) returns (y: int)
requires x >= 0
ensures y == 3*x {
        { u == 15}
        { u + 3 >= 0 && 3*(u + 3) == 54 } (A.56)
        { u + 3 >= 0 && forall y' :: y' == 3*(u + 3) ==> y' == 54 }
        t := Triple(u + 3);
        { t == 54 }
}
```

### Common `documentclass` options

| | |
|---|---|
| `10pt/11pt/12pt` | Font size. |
| `letterpaper/a4paper` | Paper size. |
| `twocolumn` | Use two columns. |
| `twoside` | Set margins for two-sided. |
| `landscape` | Landscape orientation. Must use `dvips -t landscape`. |
| `draft` | Double-space lines. |

Usage: `\documentclass[`*opt,opt*`]{`*class*`}`.

### Packages

| | |
|---|---|
| `fullpage` | Use 1 inch margins. |
| `anysize` | Set margins: `\marginsize{`*l*`}{`*r*`}{`*t*`}{`*b*`}`. |
| `multicol` | Use *n* columns: `\begin{multicols}{`*n*`}`. |
| `latexsym` | Use LaTeX symbol font. |
| `graphicx` | Show image: `\includegraphics[width=`*x*`]{`*file*`}`. |
| `url` | Insert URL: `\url{`*http://...*`}`. |

Use before `\begin{document}`. Usage: `\usepackage{`*package*`}`

### Title

| | |
|---|---|
| `\author{`*text*`}` | Author of document. |
| `\title{`*text*`}` | Title of document. |
| `\date{`*text*`}` | Date. |

These commands go before `\begin{document}`. The declaration `\maketitle` goes at the top of the document.

### Miscellaneous

| | |
|---|---|
| `\pagestyle{empty}` | Empty header, footer and no page numbers. |
| `\tableofcontents` | Add a table of contents here. |

## Document structure

`\part{`*title*`}`
`\chapter{`*title*`}`
`\section{`*title*`}`
`\subsection{`*title*`}`
`\subsubsection{`*title*`}`
`\paragraph{`*title*`}`
`\subparagraph{`*title*`}`

Use `\setcounter{secnumdepth}{`*x*`}` suppresses heading numbers of depth $> x$, where `chapter` has depth 0. Use a `*`, as in `\section*{`*title*`}`, to not number a particular item—these items will also not appear in the table of contents.

### Text environments

| | |
|---|---|
| `\begin{comment}` | Comment (not printed). Requires `verbatim` package. |
| `\begin{quote}` | Indented quotation block. |
| `\begin{quotation}` | Like `quote` with indented paragraphs. |
| `\begin{verse}` | Quotation block for verse. |

### Lists

| | |
|---|---|
| `\begin{enumerate}` | Numbered list. |
| `\begin{itemize}` | Bulleted list. |
| `\begin{description}` | Description list. |
| `\item` *text* | Add an item. |
| `\item[`*x*`]` *text* | Use *x* instead of normal bullet or number. Required for descriptions. |

### References

| | |
|---|---|
| `\label{`*marker*`}` | Set a marker for cross-reference, often of the form `\label{sec:item}`. |
| `\ref{`*marker*`}` | Give section/body number of marker. |
| `\pageref{`*marker*`}` | Give page number of marker. |
| `\footnote{`*text*`}` | Print footnote at bottom of page. |

### Floating bodies

| | |
|---|---|
| `\begin{table}[`*place*`]` | Add numbered table. |
| `\begin{figure}[`*place*`]` | Add numbered figure. |
| `\begin{equation}[`*place*`]` | Add numbered equation. |
| `\caption{`*text*`}` | Caption for the body. |

The *place* is a list valid placements for the body. `t`=top, `h`=here, `b`=bottom, `p`=separate page, `!`=place even if ugly. Captions and label markers should be within the environment.

# Text properties

## Font face

| *Command* | *Declaration* | *Effect* |
|---|---|---|
| `\textrm{`*text*`}` | `{\rmfamily` *text*`}` | Roman family |
| `\textsf{`*text*`}` | `{\sffamily` *text*`}` | Sans serif family |
| `\texttt{`*text*`}` | `{\ttfamily` *text*`}` | `Typewriter family` |
| `\textmd{`*text*`}` | `{\mdseries` *text*`}` | Medium series |
| `\textbf{`*text*`}` | `{\bfseries` *text*`}` | **Bold series** |
| `\textup{`*text*`}` | `{\upshape` *text*`}` | Upright shape |
| `\textit{`*text*`}` | `{\itshape` *text*`}` | *Italic shape* |
| `\textsl{`*text*`}` | `{\slshape` *text*`}` | *Slanted shape* |
| `\textsc{`*text*`}` | `{\scshape` *text*`}` | Small Caps shape |
| `\emph{`*text*`}` | `{\em` *text*`}` | *Emphasized* |
| `\textnormal{`*text*`}` | `{\normalfont` *text*`}` | Document font |
| `\underline{`*text*`}` | | Underline |

The command (t*ttt*) form handles spacing better than the declaration (t*tt*) form.

## Font size

| | | | |
|---|---|---|---|
| `\tiny` | tiny | `\Large` | Large |
| `\scriptsize` | scriptsize | `\LARGE` | LARGE |
| `\footnotesize` | footnotesize | `\huge` | huge |
| `\small` | small | `\Huge` | Huge |
| `\normalsize` | normalsize | | |
| `\large` | large | | |

These are declarations and should be used in the form `{\small ...}`, or without braces to affect the entire document.

## Verbatim text

| | |
|---|---|
| `\begin{verbatim}` | Verbatim environment. |
| `\begin{verbatim*}` | Spaces are shown as ␣. |
| `\verb!text!` | Text between the delimiting characters (in this case '`!`') is verbatim. |

## Justification

| *Environment* | *Declaration* |
|---|---|
| `\begin{center}` | `\centering` |
| `\begin{flushleft}` | `\raggedright` |
| `\begin{flushright}` | `\raggedleft` |

## Miscellaneous

`\linespread{`$x$`}` changes the line spacing by the multiplier $x$.

# Text-mode symbols

## Symbols

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| & | `\&` | _ | `\_` | ... | `\ldots` | • | `\textbullet` |
| $ | `\$` | ^ | `\^{}` | \| | `\textbar` | \ | `\textbackslash` |
| % | `\%` | ~ | `\~{}` | # | `\#` | § | `\S` |

## Accents

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ò | `\‘o` | ó | `\’o` | ô | `\^o` | õ | `\~o` | ō | `\=o` |
| ȯ | `\.o` | ö | `\"o` | o͡ | `\c o` | ŏ | `\v o` | ő | `\H o` |
| ç | `\c c` | o̲ | `\d o` | o͟ | `\b o` | o͡o | `\t oo` | œ | `\oe` |
| Œ | `\OE` | æ | `\ae` | Æ | `\AE` | å | `\aa` | Å | `\AA` |
| ø | `\o` | Ø | `\O` | ł | `\l` | Ł | `\L` | ı | `\i` |
| ȷ | `\j` | ¡ | `~‘` | ¿ | `?‘` | | | | |

## Delimiters

| | | | | | |
|---|---|---|---|---|---|
| ‘ | ‘ | “ | ‘‘ | { | `\{` | [ | `[` | ( | `(` | < | `\textless` |
| ’ | ’ | ” | ’’ | } | `\}` | ] | `]` | ) | `)` | > | `\textgreater` |

## Dashes

| *Name* | *Source* | *Example* | *Usage* |
|---|---|---|---|
| hyphen | `-` | X-ray | In words. |
| en-dash | `--` | 1–5 | Between numbers. |
| em-dash | `---` | Yes—or no? | Punctuation. |

## Line and page breaks

| | |
|---|---|
| `\\` | Begin new line without new paragraph. |
| `\\*` | Prohibit pagebreak after linebreak. |
| `\kill` | Don't print current line. |
| `\pagebreak` | Start new page. |
| `\noindent` | Do not indent current line. |

## Miscellaneous

| | |
|---|---|
| `\today` | May 27, 2024. |
| `$\sim$` | Prints ∼ instead of `\~{}`, which makes ˜. |
| `~` | Space, disallow linebreak (`W.J.~Clinton`). |
| `\@.` | Indicate that the `.` ends a sentence when following an uppercase letter. |
| `\hspace{`$l$`}` | Horizontal space of length $l$ (Ex: $l$ = `20pt`). |
| `\vspace{`$l$`}` | Vertical space of length $l$. |
| `\rule{`$w$`}{`$h$`}` | Line of width $w$ and height $h$. |

# Tabular environments

## `tabbing` environment

`\=` Set tab stop. `\>` Go to tab stop.

Tab stops can be set on "invisible" lines with `\kill` at the end of the line. Normally `\\` is used to separate lines.

## `tabular` environment

`\begin{array}[`*pos*`]{`*cols*`}`
`\begin{tabular}[`*pos*`]{`*cols*`}`
`\begin{tabular*}{`*width*`}[`*pos*`]{`*cols*`}`

### `tabular` column specification

| | |
|---|---|
| `l` | Left-justified column. |
| `c` | Centered column. |
| `r` | Right-justified column. |
| `p{`*width*`}` | Same as `\parbox[t]{`*width*`}`. |
| `@{`*decl*`}` | Insert *decl* instead of inter-column space. |
| `\|` | Inserts a vertical line between columns. |

### `tabular` elements

| | |
|---|---|
| `\hline` | Horizontal line between rows. |
| `\cline{`$x$-$y$`}` | Horizontal line across columns $x$ through $y$. |
| `\multicolumn{`$n$`}{`*cols*`}{`*text*`}` | A cell that spans $n$ columns, with *cols* column specification. |

# Math mode

For inline math, use `\(...\)` or `$...$`. For displayed math, use `\[...\]` or `\begin{equation}`.

| | | | |
|---|---|---|---|
| Superscript$^x$ | `^{x}` | Subscript$_x$ | `_{x}` |
| $\frac{x}{y}$ | `\frac{x}{y}` | $\sum_{k=1}^{n}$ | `\sum_{k=1}^n` |
| $\sqrt[n]{x}$ | `\sqrt[n]{x}` | $\prod_{k=1}^{n}$ | `\prod_{k=1}^n` |

## Math-mode symbols

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\leq$ | `\leq` | $\geq$ | `\geq` | $\neq$ | `\neq` | $\approx$ | `\approx` |
| $\times$ | `\times` | $\div$ | `\div` | $\pm$ | `\pm` | $\cdot$ | `\cdot` |
| $^\circ$ | `^{\circ}` | $\circ$ | `\circ` | $\prime$ | `\prime` | $\cdots$ | `\cdots` |
| $\infty$ | `\infty` | $\neg$ | `\neg` | $\wedge$ | `\wedge` | $\vee$ | `\vee` |
| $\supset$ | `\supset` | $\forall$ | `\forall` | $\in$ | `\in` | $\rightarrow$ | `\rightarrow` |
| $\subset$ | `\subset` | $\exists$ | `\exists` | $\notin$ | `\notin` | $\Rightarrow$ | `\Rightarrow` |
| $\cup$ | `\cup` | $\cap$ | `\cap` | $\mid$ | `\mid` | $\Leftrightarrow$ | `\Leftrightarrow` |
| $\dot{a}$ | `\dot a` | $\hat{a}$ | `\hat a` | $\bar{a}$ | `\bar a` | $\tilde{a}$ | `\tilde a` |
| $\alpha$ | `\alpha` | $\beta$ | `\beta` | $\gamma$ | `\gamma` | $\delta$ | `\delta` |
| $\epsilon$ | `\epsilon` | $\zeta$ | `\zeta` | $\eta$ | `\eta` | $\varepsilon$ | `\varepsilon` |
| $\theta$ | `\theta` | $\iota$ | `\iota` | $\kappa$ | `\kappa` | $\vartheta$ | `\vartheta` |
| $\lambda$ | `\lambda` | $\mu$ | `\mu` | $\nu$ | `\nu` | $\xi$ | `\xi` |
| $\pi$ | `\pi` | $\rho$ | `\rho` | $\sigma$ | `\sigma` | $\tau$ | `\tau` |
| $\upsilon$ | `\upsilon` | $\phi$ | `\phi` | $\chi$ | `\chi` | $\psi$ | `\psi` |
| $\omega$ | `\omega` | $\Gamma$ | `\Gamma` | $\Delta$ | `\Delta` | $\Theta$ | `\Theta` |
| $\Lambda$ | `\Lambda` | $\Xi$ | `\Xi` | $\Pi$ | `\Pi` | $\Sigma$ | `\Sigma` |
| $\Upsilon$ | `\Upsilon` | $\Phi$ | `\Phi` | $\Psi$ | `\Psi` | $\Omega$ | `\Omega` |

# Bibliography and citations

When using BibTeX, you need to run `latex`, `bibtex`, and `latex` twice more to resolve dependencies.

## Citation types

| | |
|---|---|
| `\cite{`*key*`}` | Full author list and year. (Watson and Crick 1953) |
| `\citeA{`*key*`}` | Full author list. (Watson and Crick) |
| `\citeN{`*key*`}` | Full author list and year. Watson and Crick (1953) |
| `\shortcite{`*key*`}` | Abbreviated author list and year. ? |
| `\shortciteA{`*key*`}` | Abbreviated author list. ? |
| `\shortciteN{`*key*`}` | Abbreviated author list and year. ? |
| `\citeyear{`*key*`}` | Cite year only. (1953) |

All the above have an `NP` variant without parentheses; Ex. `\citeNP`.

## BibTeX entry types

| | |
|---|---|
| `@article` | Journal or magazine article. |
| `@book` | Book with publisher. |
| `@booklet` | Book without publisher. |
| `@conference` | Article in conference proceedings. |
| `@inbook` | A part of a book and/or range of pages. |
| `@incollection` | A part of book with its own title. |
| `@misc` | If nothing else fits. |
| `@phdthesis` | PhD. thesis. |
| `@proceedings` | Proceedings of a conference. |
| `@techreport` | Tech report, usually numbered in series. |
| `@unpublished` | Unpublished. |

### BibTeX fields

| | |
|---|---|
| address | Address of publisher. Not necessary for major publishers. |
| author | Names of authors, of format .... |
| booktitle | Title of book when part of it is cited. |
| chapter | Chapter or section number. |
| edition | Edition of a book. |
| editor | Names of editors. |
| institution | Sponsoring institution of tech. report. |
| journal | Journal name. |
| key | Used for cross ref. when no author. |
| month | Month published. Use 3-letter abbreviation. |
| note | Any additional information. |
| number | Number of journal or magazine. |
| organization | Organization that sponsors a conference. |
| pages | Page range (2,6,9--12). |
| publisher | Publisher's name. |
| school | Name of school (for thesis). |
| series | Name of series of books. |
| title | Title of work. |
| type | Type of tech. report, ex. "Research Note". |
| volume | Volume of a journal or book. |
| year | Year of publication. |

Not all fields need to be filled. See example below.

### Common BibTeX style files

| | | | |
|---|---|---|---|
| abbrv | Standard | abstract | alpha with abstract |
| alpha | Standard | apa | APA |
| plain | Standard | unsrt | Unsorted |

The LaTeX document should have the following two lines just before \end{document}, where bibfile.bib is the name of the BibTeX file.

```
\bibliographystyle{plain}
\bibliography{bibfile}
```

### BibTeX example

The BibTeX database goes in a file called *file*.bib, which is processed with bibtex file.

```
@String{N = {Na\-ture}}
@Article{WC:1953,
  author  = {James Watson and Francis Crick},
  title   = {A structure for Deoxyribose Nucleic Acid},
  journal = N,
  volume  = {171},
  pages   = {737},
  year    = 1953
}
```

## Sample LaTeX document

```
\documentclass[11pt]{article}
\usepackage{fullpage}
\title{Template}
\author{Name}
\begin{document}
\maketitle

\section{section}
\subsection*{subsection without number}
text \textbf{bold text} text. Some math: $2+2=5$
\subsection{subsection}
text \emph{emphasized text} text. \cite{WC:1953}
discovered the structure of DNA.

A table:
\begin{table}[!th]
\begin{tabular}{|l|c|r|}
\hline
first  &  row  &  data \\
second &  row  &  data \\
\hline
\end{tabular}
\caption{This is the caption}
\label{ex:table}
\end{table}

The table is numbered \ref{ex:table}.
\end{document}
```



http://wch.github.io/latexsheet/