The second midterm may verify your understanding and knowledge of anything from the syllabus. But you should start by making sure that you know the fundamentals below very well.

**Fundamental concepts**

- function, domain, range [p4]
- increasing/decreasing/monotonic function [p6]
- one-to-one function, invertible function, the inverse function [p34, 35, 36]
- polynomial/rational function [p21]
- interval, closed interval, open interval [p2]
- limit [p111]
- continuity [p81]
- derivative (measures rate of change), differentiability [p121, 129, 150, equation (4) on p153]
- absolute minimum/maximum, local minimum/maximum [p215, 216]
- antiderivative/indefinite integral [p275, 276]

**Fundamental theorems/facts**

- the equation of a line [p16]
- the quadratic function [roots, sign, monotonicity intervals, concavity] [see also “the quadratic function (roots and sign)” in the schedule of lectures and assignments]
- trigonometry [Sections 1.4, 1.5, Problem 6(c) on Workshop 1, the second page of the textbook (with formulas)]
- basic limit laws [p 77]
- basic laws of continuity [p 83], continuity of composite functions [Thm 5, p 85], continuity of the inverse function [Thm 4, p 85]
- Rational functions, trigonometric functions, \( x \rightarrow e^x, x \rightarrow \ln x, x \rightarrow x^a \) are continuous on their domains
- The range (=image) of a continuous function \( f : I \rightarrow \mathbb{R} \) defined on an interval \( I \) is an interval. [The Intermediate Value Thm]
- The range (=image) of a continuous function \( f : [a, b] \rightarrow \mathbb{R} \) defined on a closed bounded interval \([a, b]\) is a closed bounded interval. [see Thm 1, p 216]
- The Squeeze Thm [Thm 1, p 96].
- \( \lim_{\theta \to 0} \frac{\sin \theta}{\theta} = 1 \) [p96-98]
- \( \lim_{x \to -\infty} x^n = \infty \text{ if } n > 0, \, \lim_{x \to -\infty} x^{-n} = 0 \text{ if } n > 0 \) [Footnote 1]

[Footnote 1] This is a particular case of \( \lim_{x \to x_0} \frac{1}{f(x)} = 0 \text{ if } \lim_{x \to x_0} f(x) = \infty \text{ or } -\infty \).
\[
\lim_{x \to -\infty} x^n = \begin{cases} 
\infty, & \text{if } n \text{ is an even positive integer,} \\
-\infty, & \text{if } n \text{ is an odd positive integer.}
\end{cases}
\]

\[
\lim_{x \to -\infty} x^{-n} = 0 \text{ if } n \text{ is a positive integer.}
\]

\[
\lim_{x \to 0^-} f(x) = \infty \text{ if } \lim_{x \to 0^-} f(x) = 0 \text{ and } f(x) > 0 \text{ for all } x \neq x_0 \text{ in some interval } (x_0 - \epsilon, x_0 + \epsilon)
\]

\[
\lim_{x \to 0^+} f(x) = \infty \text{ if } \lim_{x \to 0^+} f(x) = 0 \text{ and } f(x) > 0 \text{ for all } x \in \text{ some interval } (x_0, x_0 + \epsilon), \epsilon > 0;
\]

\[
\lim_{x \to x_0^-} \frac{1}{f(x)} = \infty \text{ if } \lim_{x \to x_0^-} f(x) = 0 \text{ and } f(x) > 0 \text{ for all } x \neq x_0 \text{ in some interval } (x_0 - \epsilon, x_0 + \epsilon), \epsilon > 0;
\]

\[
\lim_{x \to x_0^+} \frac{1}{f(x)} = -\infty \text{ if } \lim_{x \to x_0^+} f(x) = 0 \text{ and } f(x) < 0 \text{ for all } x \neq x_0 \text{ in some interval } (x_0 - \epsilon, x_0), \epsilon > 0;
\]

\[
\lim_{x \to x_0^-} \ln x = -\infty \text{ if } \lim_{x \to x_0^-} f(x) = 0 \text{ and } f(x) < 0 \text{ for all } x \in \text{ some interval } (x_0 - \epsilon, x_0), \epsilon > 0;
\]

\[
\lim_{x \to 0^+} e^x = 0, \quad \lim_{x \to \infty} e^x = \infty,
\]

\[
\lim_{x \to 0^+} \ln x = -\infty, \quad \lim_{x \to \infty} \ln x = \infty
\]

FIRST AND SECOND LIST OF DERIVATIVES (see website)

FIRST AND SECOND LIST OF INDEFINITE INTEGRALS (see website)

the equation of the tangent line to the graph of a differentiable function [Dfn, p 121]

linearity rules for differentiability/derivatives [p 132]; Linearity of the Indefinite Integrals [p 277]

differentiability implies continuity [p 136]

The Chain Rule [p 169]

product and quotient rules [p 143, 145], the derivative of the inverse function [p 178]

approximating \( f(x) \) by its linearization [p 210]

Fermat’s thm on local extrema [p 218]

Rolle’s thm [p 220]

The Mean Value Thm [p 226] and its consequences (Corollary on p 227 and The Sign of the Derivative thm on p 227)

First Derivative Test for Critical Points regarding local extrema [p 229], Second Derivative Test for local extrema [p 237]

Test for Concavity/Inflection Points [p 235]

L’Hôpital’s Rules [p 241, 244], \( \lim_{x \to \infty} \frac{e^x}{x^n} = \infty \) [p245]