Midterm two is cumulative, but the emphasis is on the topics discussed in lecture during Weeks 4, 5, 6, and 7, namely, sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, and 3.4. The relevant homework assignments are “online homeworks” four, five, six, and seven (except for the 3.5 problems), and “textbook homeworks” (i.e. paper and pen) four, five, six, and seven (except for the 3.5 problems). Below is a summary of the topics/skills you need to master from each section; in some cases, example problems from the textbook homework assignments are provided to illustrate what is meant by the particular skill. Remember that all of the “textbook homework” problems are on the homework page of the course website.

If you know how to solve all of the examples from lecture, the online homework, and the assigned textbook homework problems on your own and without any assistance, then you should do very well on this exam. Don’t worry about problems that require calculator use to evaluate limits (e.g. online HW 2.1.16 and online HW 2.2.4).

- Section 2.1: Be able to calculate the average rate of change of a function on a given interval; i.e. the average rate of change of $f$ on the interval $[a, b]$ is $\frac{f(b) - f(a)}{b - a}$.
Understand the geometric interpretation of average rate of change; i.e. the average rate of change of $f$ on the interval $[a, b]$ is the slope of the line connecting the points $(a, f(a))$ and $(b, f(b))$.

- Section 2.2: Be able to find derivatives using the limit definition:
$$f'(x) = \lim_{h \to 0} \frac{f(x + h) - f(x)}{h}$$
Know that $f'(a)$ is the slope of the tangent line to the graph of $f$ at the point $(a, f(a))$, and be able to use this relationship to find the equation of a tangent line to a graph at a given point. Be able to use equations of tangent lines to estimate the outputs of a function (e.g. problems like HW 2.2.13).

- Section 2.3: Understand the following relationships and be able to solve problems using them:
  - If $f'(x) > 0$ on an interval, then $f$ is increasing on that interval (and vice versa).
  - If $f'(x) < 0$ on an interval, then $f$ is decreasing on that interval (and vice versa).

- Section 2.4: Be able to translate equations involving derivatives to “human words” and be able to find the units of a derivative (e.g. problems like HW 2.4.4 and 2.4.11).
• Section 2.5: Be able to calculate second derivatives. Understand the following relationships and be able to solve problems using them:

- If $f''(x) > 0$ on an interval, then $f'$ is increasing on that interval and the graph of $f$ is concave up that interval\(^1\).
- If $f''(x) < 0$ on an interval, then $f'$ is decreasing on that interval and the graph of $f$ is concave down that interval\(^2\).

Know that the first derivative of a position function is the velocity function, and the second derivative of a position function is the acceleration function.

• Section 2.6: Given the graph of a function $f$, be able to identify the $x$ values at which $f'(x)$ does not exist.

• Section 3.1: Know how to take derivatives of constant functions, linear functions, and power functions ($y = x^n$). Know how to use these derivatives in context; e.g. finding the equation of a tangent line to a graph at a certain point, solving an inequality to determine intervals on which the graph of a function is increasing, decreasing, concave up, or concave down, etc.

• Section 3.2: Know how to take derivatives of exponential functions ($y = a^x$). Know how to use these derivatives in context; e.g. finding the equation of a tangent line to a graph at a certain point, solving an inequality to determine intervals on which the graph of a function is increasing, decreasing, concave up, or concave down, etc.

• Section 3.3: Know how to take derivatives using the product rule and the quotient rule. Know how to use these derivatives in context; e.g. finding the equation of a tangent line to a graph at a certain point, solving an inequality to determine intervals on which the graph of a function is increasing, decreasing, concave up, or concave down, etc.

• Section 3.4: Know how to take derivatives using the chain rule. Know how to use these derivatives in context; e.g. finding the equation of a tangent line to a graph at a certain point, solving an inequality to determine intervals on which the graph of a function is increasing, decreasing, concave up, or concave down, etc.

\(^1\)Any one of these three implies the other two.
\(^2\)Any one of these three implies the other two.