Supplementary problems

Your primary source of offline problems should be the CLP problem book for Mathematics 100 and 180 which you can find linked from the course website. Below we have constructed a list of similar problems from the 3 supplementary texts.

Supplementary Texts

MOOCulus: https://mooculus.osu.edu/handouts
Fowler, Snapp
This is a very competent standard treatment. The answers to every problem are given at the end, but without solutions.

APEX Calculus: http://www.apexcalculus.com/downloads/
Hartman, et al
Problem sets are broken up into conceptual and terminology, practice, and review, and chapters have summaries at the end, all of which is very nice. I like the prose in some sections, and dislike it in others. In the multivariate section they have fancy interactive graphics, which is pretty outstanding if irrelevant. Odd problems have answers at the end, without solutions.

Active Calculus: https://opencalculus.wordpress.com/about/download-active-calculus/
Boeklins, et al
This book is meant to be used in an active-learning environment. The text has ideas for activities, and the prose is very conversational. There are not many exercises, but they tend to be multi-part and meant to guide students, rather than practice rules. Problems do not have answers.

2 Limits and derivatives

2.1 The tangent and velocity problem

Standard Problems:

Active Calculus: Section 1.3, pages 30-31, problem 1

Challenge Problems:

Active Calculus: Section 1.3, page 31, problem 2

Conceptual Problems:

APEX Calculus: Section 2.1, page 69, problems 1, 2
APEX Calculus: Section 2.2, page 77, problems 1, 11

Noteworthy Problems:

Active Calculus: Section 1.1, pages 7-10, problems 1-3. Multi-part problems that lead students through finding average rate of change in different scenarios, with models meant to correspond to something real. Each problem has different nuances.

2.2 The limit of a function

Standard Problems:

MOOCulus: Section 1.1, page 23, problems 1-8
APEX Calculus: Section 1.4, page 36, problems 13-21

Challenge Problems:

MOOCulus: Section 1.1, page 24, problem 10

Conceptual Problems:

MOOCulus: Section 1.1, page 23, problems 1,8,9
APEX Calculus: Section 1.1, page 8, problems 1,3,4
APEX Calculus: Section 1.3, page 28, problems 1,2
APEX Calculus: Section 1.4, pages 35-36, problems 1-12
APEX Calculus: Section 1.5, page 45, problem 43
APEX Calculus: Section 1.6, pages 55-56, problems 1, 3, 4, 8, 11
Active Calculus: Section 1.2, pages 20-21, problem 3

Noteworthy Problems:

MOOCulus: Section 1.1, page 24, problem 10: particularly nice problem evaluating a limit relating to objects moving at relativistic speeds. A little ugly but nicely interesting.
APEX Calculus: Section 1.3, page 28, problem 5: Given two functions that go to 0, their quotient goes to 2. What does it mean about their relative sizes?

2.3 Calculating limits with limit laws

Standard Problems:

MOOCulus: Section 1.3, page 35, problems 1-15
MOOCulus: Section 2.1, page 38, problems 1-10
APEX Calculus: Section 1.1, page 8, problems 6-15
APEX Calculus: Section 1.3, pages 28-29, problems 18-36
APEX Calculus: Section 1.4, page 36, problems 22-24

Challenge Problems:

MOOCulus: Section 1.3, page 35, problems 6,13

Conceptual Problems:

MOOCulus: Section 1.3, page 35, problems 7,15
APEX Calculus: Section 1.3, page 28, problems 5-17

Motivational Problems:

Active Calculus: Section 1.2, pages 19-20, problems 1-2: multi-part problems leading students to evaluating limits of rational functions

2.4 Precise definition of limits

(basically: we won't teach this)
MOOCulus: Section 1.2
APEX Calculus: Section 1.2

2.5 Continuity

Standard Problems:

MOOCulus: Section 2.3, page 46, problems 1-10
APEX Calculus: Section 1.5, page 45, problems 19-32, 37-40; you'll need to tell students that "bisection method" is just how we found roots of continuous functions using the intermediate value theorem.

Conceptual Problems:

APEX Calculus: Section 1.5, pages 44-45, problems 1-3, 5-17, 33-36

2.6 Limits at infinity

Standard Problems:

MOOCulus: Section 2.2, page 42, problems 1-10, 12
APEX Calculus: Section 1.6, page 56, problems 19-28

Challenge Problems:

MOOCulus: Section 2.2, page 42, problems 8, 11

Conceptual Problems:

APEX Calculus: Section 1.6, pages 55-56, problems 1-4, 7-10, 12-14

Noteworthy Problems:

MOOCulus: Section 2.2, page 42, problem 11: a moderately difficult limit, ostensibly modelling the population of feral cats. The model shows the population stabilizing over time.

Motivational Problems:

MOOCulus: Section 2.2, page 42, problems 11,12. Limits at infinity that can be figured out by testing large numbers

2.7 Derivatives and rates of change

Standard Problems:

MOOCulus: Section 3.1, page 53, problems 7

Conceptual Problems:

MOOCulus: Section 3.1, page 54, problems 1-5
APEX Calculus: Section 2.1, pages 69-70, problems 2, 26-30
APEX Calculus: Section 2.2, page 77, problems 3-6, 8-9, 15-18

Noteworthy Problems:

APEX Calculus: Section 2.2, page 77, problem 7: getting a feel for rates of change. Execution is pretty handwavy, but nice idea.
APEX Calculus: Section 2.2, page 77, problems 2, 10, 12-14: dealing with interpretations of derivatives as rates of change of functions describing various concrete situations other than motion.
Active Calculus: Section 1.5, page 50, problems 2,4: interpreting rates of change in various models.

2.8 The derivative as a function

Standard Problems:

MOOCulus: Section 3.1, page 53, problems 8-10
APEX Calculus: Section 2.1, pages 69-70, problems 6-12, 24

Challenge Problems:

Active Calculus: Section 1.7, pages 75-76, problem 4

Conceptual Problems:

MOOCulus: Section 3.1, page 54, problem 6
Active Calculus: Section 1.7, pages 74-75, problems 1-3

Noteworthy Problems:

MOOCulus: Section 3.1, page 53, problem 2: classic problem, showing four graphs, two of which are the derivatives of the other two

3 Differentiation Rules

3.1 Derivatives of polynomials and exponentials

Standard Problems:

MOOCulus: Section 3.2, pages 62-63, problems 1-19, 24, 27, 28
APEX Calculus: Section 2.3, page 84, problems 11-13, 15, 18

Challenge Problems:

MOOCulus: Section 3.2, pages 62-63, problems 20-23, 29

Conceptual Problems:

MOOCulus: Section 3.2, page 62, problems 25, 26
Active Calculus: Section 2.1, pages 94-95, problems 1-3: for problem 1(d), tell students "local linearization" is just the tangent line, or just have them skip this part

Noteworthy Problems:

APEX Calculus: Section 3.2, page 84, problems 3,4,7: give an example of a function with this derivative

3.2 The product and quotient rules

Standard Problems:

MOOCulus: Section 5.1, page 85, problems 1-6
MOOCulus: Section 5.2, page 85, problems 1-7
APEX Calculus: Section 2.4, pages 94-95, problems 17, 20-22, 34, 36, 37

Challenge Problems:

APEX Calculus: Section 2.4, page 94, problems 7-14

Conceptual Problems:

MOOCulus: Section 5.1, page 85, problems 8-11
MOOCulus: Section 5.2, page 85, problems 8-12
APEX Calculus: Section 2.4, pages 94-95, problems 1, 2, 5, 41
Active Calculus: Section 2.3, pages 110-111, problems 1-3: For problem 1(d), let students know that the "local linearization" is the tangent line

Noteworthy Problems:

MOOCulus: Section 5.1, page 85, problem 12: prove the product rule for the product of three functions
Active Calculus: Section 3.2, pages 111-112, problems 4, 5: given a very intuitive physical measure, explan the meaning of derivaties, and several related formulas. Parts of problem 4 seem easier without calculus, though.

3.3 Derivatives of trig functions

Standard Problems:

MOOCulus: Section 7.1, page 112, problems 2-4, 6, 9-11,15,18-21, 23
APEX Calculus: Section 2.3, page 84, problems 14, 16, 21
APEX Calculus: Section 2.4, pages 94-95, problems 16, 18, 19, 23-29, 35, 38-40
Active Calculus: Section 2.4, page 118, problem 3

Challenge Problems:

APEX Calculus: Section 1.3, page 29, problems 37, 38, 40

Conceptual Problems:

APEX Calculus: Section 2.4, page 94, problem 3

3.4 The chain rule

Standard Problems:

MOOCulus: Section 6.1, pages 95-96, problems 1-35, 37-39
APEX Calculus: Section 2.5, page 105, problems 7-15, 26-28
Active Calculus: Section 2.5, page 127, problems 1, 2

Challenge Problems:

MOOCulus: Section 6.1, pages 95-96, problems 36, 40

Conceptual Problems:

APEX Calculus: Section 2.5, page 105, problems 1, 6
Active Calculus: Section 2.5, page 127-128, problem 3

Noteworthy Problems:

Active Calculus: Section 2.5, page 128, problem 4: foreshadowing related rates

1.6 Inverse functions and logarithms

Standard Problems:

APEX Calculus: Section 2.7, page 122, problems 1-4

Conceptual Problems:

APEX Calculus: Section 2.7, page 122, problems 5-8

3.5 Implicit Differentiation

Standard Problems:

MOOCulus: Section 6.2, page 101, problems 1-8, 10-15
MOOCulus: Section 7.2, page 120, problems 2-7
APEX Calculus: Section 2.5, pages 115-116, problems 13-23, 28-35: for some problems, make sure students know Leibnitz notation for second derivative
Active Calculus: Section 2.6, page 138, problem 1
Active Calculus: Section 2.7, page 148, problems 1, 2

Challenge Problems:

MOOCulus: Section 6.2, page 101, problem 9: this is also a pretty nice problem, involving students setting up an equation from a description, but the differentiation is a bear

Conceptual Problems:

MOOCulus: Section 7.2, page 120, problem 1
APEX Calculus: Section 2.6, page 115, problems 1, 2

Noteworthy Problems:

Active Calculus: Section 2.7, page 148, problem 3: figuring out the derivative of a^x, with lots of help

3.6 Derivatives of logarithmic functions

Standard Problems:

MOOCulus: Section 6.3, page 106, problems 1-10
APEX Calculus: Section 2.6, page 116, problems 36-41
Active Calculus: Section 2.4, page 117, problem 1

Conceptual Problems:

Active Calculus: Section 2.2, page 100, problem 1

Noteworthy Problems:

MOOCulus: Section 6.3, page 106, problem 10: use logarithmic differentitation to derive the product rule over three functions; extremely cute
APEX Calculus: Section 2.3, page 84, problem 26: use logs rules to figure out the derivative of a logarithm with arbitrary constant as a base

3.7 Rates of change in sciences

Standard Problems:

MOOCulus: Section 8.2, pages 134-135, problems 1-4, 7

3.8 Exponential growth and decay

Standard Problems:

MOOCulus: Section 8.2, page 134, problems 5,6

3.9 Related rates

Standard Problems:

MOOCulus: Section 8.3, pages 143-145, problems 1-20
APEX Calculus: Section 4.2, pages 171-172, problems 3-15
Active Calculus: Section 3.5, pages 206-207, problems 1-4

Conceptual Problems:

APEX Calculus: Section 4.2, page 171, problem 1

3.10 Linear approximation and differentials

Standard Problems:

MOOCulus: Section 10.1, page 165, problems 1-10
Active Calculus: Section 1.8, pages 83-84, problems 1-3
APEX Calculus: Section 4.4, page 186, problems 6-16, 30-33

Challenge Problems:

Active Calculus: Section 1.8, page 85, problem 4

Conceptual Problems:

APEX Calculus: Section 4.4, page 186, problems 2, 3, 5

Noteworthy Problems:

APEX Calculus: Section 4.4 pages 186-187, problems 34-38: using differentials to answer a number of questions related to error in surveying techniques

Course notes: Taylor

1 Taylor polynomials

Standard Problems:

APEX Calculus: Section 8.7, page 475, problems 5-20, 29-33: define Maclaurin for students

Conceptual Problems:

APEX Calculus: Section 8.7, page 475, problems 1-4: define Maclaurin for students
Active Calculus: Section 8.5, page 518, problem 1

2 Taylor's formula with remainder

Standard Problems:

APEX Calculus: Section 8.7, page 475, problems 21-28
APEX Calculus: Section 88, page 487, problems 3-12, 25-30
Active Calculus: Section 8.5, page 518, problem 2

Challenge Problems:

Active Calculus: Section 8.5, pages 518-519, problem 3

Conceptual Problems:

APEX Calculus: Section 8.8, page 487, problems 1, 17-20

4 Applications of differentiation

4.1 Maximum and minimum values

Standard Problems:

MOOCulus: Section 4.1, page 67, problems 1-11
MOOCulus: Section 9.1, page 149, problems 1-10
APEX Calculus: Section 3.1, page 130, problems 15-24
Active Calculus: Section 3.3, page 191, problem 4

Conceptual Problems:

MOOCulus: Section 4.1, page 67, problem 12
APEX Calculus: Section 3.1, page 129, problems 1-7
Active Calculus: Section 3.3, pages 190-191, problems 1,3

Challenge Problems:

Active Calculus: Section 3.3, page 190, problem 2

Noteworthy Problems:

MOOCulus: Section 4.1, page 67, problem 13: given $f(x) = x^3 + cx + 1$, how many extrema are there? Light abstraction, breaks down into nice cases.
APEX Calculus: Section 3.1, pages 129-130, problems 8-14: Given the graph of a function, find the derivative at the selected points. The functions are obnoxious to differentitate, but (except for one red herring–a nice touch) all the indicated points are extrema.

4.2 The mean value theorem

Standard Problems:

MOOCulus: Section 10.3, page 177, problems 1-5, 10, 11
APEX Calculus: Section 3.2, page 135, problems 3-20

Conceptual Problems:

APEX Calculus: Section 3.2, page 135, problems 1, 2

4.3 Derivatives and the shape of a graph

Standard Problems:

MOOCulus: Section 4.2, page 70, problems 1-7
MOOCulus: Section 4.3, page 74, problems 1-11
MOOCulus: Section 4.4, page 77, problems 1-10
APEX Calculus: Section 3.3, page 143, problems 14-23
Active Calculus: Section 1.6, pages 62-64, problems 1, 3, 4
Active Calculus: Section 3.1, page 172-173, problems 1, 2, 4

Conceptual Problems:

APEX Calculus: Section 3.3, page 143, problems 1-5
Active Calculus: Section 3.1, page 172, problem 3
Active Calculus: Section 3.2, pages 181-182, problems 1, 2

Challenge Problems:

Active Calculus: Section 3.2, page 182, problem 3

Noteworthy Problems:

MOOCulus: Section 4.2, page 70, problem 8: exploring critical points of a general quadratic equation

4.5 Curve sketching

Standard Problems:

MOOCulus: Section 4.5, page 81, problems 1-8
APEX Calculus: Section 3.5, page 158, problems 12-25

Challenge Problems:

APEX Calculus: Section 3.5, page 158, problems 26-29
Active Calculus: Section 1.6, page 63, problem 2
Active Calculus: Section 2.8, page 159, problem 2

4.7 Optimization problems

Standard Problems:

MOOCulus: Section 9.2, pages 157-160, problems 1-32
APEX Calculus: Section 4.3, page 179, problems 3-17
Active Calculus: Section 3.4, page 197, problems 1-4

Conceptual Problems:

APEX Calculus: Section 4.3, page 179, problem 1

Noteworthy Problems:

MOOCulus: Section 9.2, pages 159-160, problems 24,31: classic results about inscribed figures. 31 has some trickiness if you want to give a thorough proof.
APEX Calculus: Section 4.3, page 179, problem 10: a nice example comparing optimal result to an industry standard

4.4 L'Hopital's Rule

Standard Problems:

MOOCulus: Section 8.1, pages 128-129, problems 1-49
APEX Calculus: Section 6.7, pages 331-332, problems 8-52
Active Calculus: Section 2.8, page 159, problem 3

Conceptual Problems:

APEX Calculus: Section 6.7, page 331, problems 3, 4, 6, 7
Active Calculus: Section 2.8, page 159, problem 1

Noteworthy Problems:

Active Calculus: Section 2.8, page 159, problem 4: using L'Hospital to figure out relative orders of magnitude for common functions; very important knowledge!

4.9 Antiderivatives

Standard Problems:

MOOCulus: Section 11.1, page 185, problems 1-10
APEX Calculus: Section 5.1, pages 197-198, problems 8-26, 28-38

Challenge Problems:

MOOCulus: Section 11.1, pages 185-186, problems 11-34

Conceptual Problems:

APEX Calculus: Section 5.1, page 197, problems 1-7, 27
Active Calculus: Section 4.1, page 221, problem 1