1. **(5 points)** *Using the difference quotient, calculate the derivative of* $f(x) = 2x - 5x^2$.

$$\begin{aligned} f'(x) &= \lim_{h\to 0} \frac{f(x+h) - f(x)}{h} \\ &= \lim_{h\to 0} \frac{[2(x+h) - 5(x+h)^2] - (2x - 5x^2)}{h} \\ &= \lim_{h\to 0} \frac{2x + 2h - 5x^2 - 10xh - 5h^2 - 2x + 5x^2}{h} \\ &= \lim_{h\to 0} \frac{2h - 10xh - 5h^2}{h} = \lim_{h\to 0} 2 - 10x - 5h = 2 - 10x \end{aligned}$$

2. **(4 points)** *Calculate* $\frac{d^3}{dt^3}\left(3e^t - 2\sin t + 5t^3 - 2t\right)$.

   Three differentiations will leave e^t unchanged, convert $\sin t$ to $-\cos t$, annihilate $2t$, and convert $5t^3$ to $5 \cdot 3 \cdot 2 \cdot 1t^0$, so the third derivative will be $3e^t + 2\cos t + 30$.

3. **(6 points)** *If* $g(u) = \frac{e^u + \sec u}{u^3 + \sqrt{u}}$, *calculate* $g'(u)$.

   We will use the quotient rule to find that

$$\begin{aligned} g'(u) &= \frac{(u^3 + \sqrt{u})\frac{d}{du}(e^u + \sec u) - (e^u + \sec u)\frac{d}{du}(u^3 + u^{1/2})}{(u^3 + \sqrt{u})^2} \\ &= \frac{(u^3 + \sqrt{u})(e^u + \sec u \tan u) - (e^u + \sec u)\frac{d}{du}(3u^2 + \frac{1}{2}u^{-1/2})}{(u^3 + \sqrt{u})^2} \end{aligned}$$

4. **(5 points)** *For* $y = x^3 \cot x$, *compute* $\frac{dy}{dx}$.

   Using the product rule,

$$\frac{dy}{dx} = \left(\frac{d}{dx}x^3\right)\cot x + x^3\frac{d}{dx}\cot x = 3x^2\cot x - x^3\csc^2 x.$$

5. **(2 point bonus)** *On the back of this page, find a* general *formula for* $\frac{d^n}{dx^n}\left(e^x \sin x\right)$.