1. Determine $\frac{dy}{dx}$ making any obvious simplifications.

a) $y = \frac{\sin x}{x^2}$

b) $y = 3\sin x + \cos\left(\frac{x}{2}\right) - 1$

c) $y = \sin(\sqrt[3]{2x+1})$

d) $y = \sin^7 \sqrt{x}$

e) $y = \cos x \tan x \csc x$

f) $y = \frac{x \sin x}{\cos x}$

g) $y = (x-5)^8 \cot(7x)$

h) $y = \tan^4 \sqrt{1+3x}$

i) $y = 5\cos^3(1+\tan x)$

j) $y = \frac{\cos x}{1+\sin x}$

k) $y = \sec^2(x) + \sec(x^2)$

l) $y = \tan\left(\frac{1}{x^3}\right)$

m) $y = \tan^2(\pi - x^3)$

n) $y = \frac{1+2\tan(3x)}{1-x}$

o) $y = \sqrt{1+\sin 2x}$

p) $y = \arctan(3x)$

q) $y = \sin(\cos^{-1}(x))$

r) $y = \cos^{-1}\sqrt{2x-1}$

2. If $f(x) = \cos(3x)$, determine $f^{(4)}(x)$.

3. Evaluate the following limits showing all necessary workings. Assign ∞ or $-\infty$ as appropriate.

a) $\lim_{x\to 0} \frac{\sin^2 4x}{x^2}$ b) $\lim_{x\to 0} \frac{\sin 8x}{4x}$ c) $\lim_{x\to 0} \frac{\cos x - 1}{\sin x}$

d) $\lim_{x\to 0} \frac{\sin^2(5x)}{x^2 \cos^2(2x)}$ e) $\lim_{x\to 0} \frac{1-\cos^2 x}{x^2(2+\cos x)}$

4. Use implicit differentiation to determine $\frac{dy}{dx}$.

a) $y^2 \cos^2(x) = 4$

b) $x + \sin(y) = xy$

c) $x^2 \cos y = y^2 \sin x$

5. Determine the equation of the tangent line to the curve defined by the equation $\pi(x^2 - y^2) = \cos(\pi y)$ at the point $\left(\frac{3}{2}, \frac{3}{2}\right)$

6. Determine the equation of the tangent and normal lines to the curve $y = \sin x \tan x$ at $x = \frac{\pi}{6}$.

7. Determine the equation of the tangent line to the curve $y = \cos 3x$ at the point $\left(\frac{\pi}{6}, 0\right)$. For what values of x is the tangent line horizontal if $0 \le x \le 2\pi$.

8. A man stands 12 metres away from the flagpole. He holds onto a long rope attached to the flag. As the flag is raised at a rate of 10 metres per minute, the rope runs tautly through the man's hands (so that it is always kept straight). Find the rate of change of the angle between the rope and the flagpole, at the moment when there is 24 metres of rope between the flag and the man.

9. Two sides of a triangle are 6 and 8 metres in length. If the angle between them decreases at a rate of 0.035rad/s, determine the rate at which the area is decreasing when the angle between the sides of fixed length is $\frac{\pi}{6}$.

10. Determine the exact value of the following:

a) $\cos^{-1}\left(-\frac{1}{2}\right)$ b) $\tan^{-1}(-1)$ c) $\arctan\left(\tan\left(\frac{2\pi}{3}\right)\right)$

d) $\arccos\left(\sin\left(\frac{\pi}{4}\right)\right)$ e) $\cos^{-1}(1)$ f) $\cos^{-1}\left(\sin\left(\frac{\pi}{4}\right)-\sin\left(\frac{\pi}{6}\right)\right)$

g) $\sin^{-1}\left(\cos\left(\frac{\pi}{3}\right)-\cos\left(\frac{\pi}{6}\right)\right)$