

**Question 1 [10 points]:** A water tank has the shape of an inverted cone of top radius 2 m and height 3 m. Water is leaking from the tank. When the water depth is 2 m it is decreasing at  $1/2$  m/min. At what rate is the volume of water in the tank changing at that same instant? State units with your answer. Recall that the volume of a cone is given by  $V = (\pi/3)r^2h$ .

**Question 2:**

(a)[5 points] Give the linearization  $L(x)$  of  $f(x) = x \ln(x^2 - 3)$  at  $a = 2$ .

(b)[5 points] Use a linear approximation to estimate  $\frac{1}{\sqrt{99}}$ .

**Question 3:**

(a)[3 points] Differentiate:  $g(x) = \log_7(x + \sin x)$  .

(b)[3 points] Differentiate:  $y = 3^{x^3 \sec x}$  .

(c)[4 points] Evaluate and simplify  $f''(0)$  if  $f(x) = \ln[e^x + \ln(1 + x)]$  .

**Question 4:**

(a)[5 points] Use logarithmic differentiation to compute  $f'(x)$  if  $f(x) = \sqrt{x}e^{x^3}(x^2 - 1)^5$ .

(b)[5 points] Use implicit differentiation to determine  $y'$  if  $e^x = \ln(x^2 + y^2)$ .

**Question 5:** For this question use  $f(x) = 3x^{2/3} - x$  . State clear conclusions for each of the following:

(a)[5 points] Determine the intervals of increase and decrease of  $f(x)$  .

(b)[5 points] Determine the intervals of concavity of  $f(x)$  .