ME 201 Tutorial #4 - Winter 2017
Chain Rule, Gradient Vector and Directional Derivative

1. The mass of a rocket lifting off from earth decreases due to fuel consumption at a rate of 40 *kg/s*. Using Newton's law of gravitation:

$$F = \frac{G M m}{r^2}$$

$G =$ universal gravitational constant $\left(km^3/kg\ s^2\right)$

$M =$ mass of the earth (kg)

$m =$ mass of rocket (including fuel) (kg)

$r =$ distance between rocket and center of the earth (km)

calculate how fast the magnitude F of the force of gravity is decreasing when the rocket is 6400 *km* from the center of the earth and is rising with a velocity of 100 *km/s*? (N/s)

2. Find the equation of the plane tangent to the surface of the cone $z = \sqrt{x^2 + y^2}$ at the point $\left(1, 1, \sqrt{2}\right)$

3. Given the density function $\rho(x, y, z) = x^3 y^2 z^5 - 2xz + yz + 3x$ find the rate of change of the function at the following points in the direction given:

   a. In the direction of the most rapid density increase at $(1, 2, -1)$

   b. At point $(2, 2, 1)$ in the direction away from the origin.