

1. An agriculture research shows that a certain type of orange tree will yield 400 pounds of oranges per year minus 2 pounds for each tree planted per acre. Write a function Y giving the annual yield in pounds of one-acre plot containing x such apple trees. (10%)
2. Let $f(x)=1/(x-2)$. Note that $f(0)=-1/2$ and $f(3)=1$. Is there a number x between 0 and 3 such that $f(x)=0$? Does this contradict the Intermediate Value Theorem? (10%)
3. The top portion of a coffee maker has the shape of a cone 10 cm high. The radius at the top is 4 cm. Coffee is flowing from the top section into the bottom section at a rate of $4 \text{ cm}^3/\text{s}$. At what rate is the level of coffee in the top section falling when the coffee in the top section is 4 cm deep? (10%)
4. Please solve the initial value problem (10%):
$$dy = x(x^2+1)^{1/2} dx$$
$$y(0)=1$$
5. Please find the area of the region bounded by the parabola $y = x^2 + x - 2$ and the line through $(-1, -2)$ and $(1, 0)$. (10%)
6. Suppose that a ship's anchor weighs 2 tons (4000 pounds) in water and that the anchor is hanging taut from 100 feet of cable. Find the work (unit: ft-lb) required to wind in the anchor if the cable weighs 20 pounds per foot in water. (10%)
7. Assume that the rate of growth of a population of fruit flies is proportional to the size of the population at each instant of time. If 100 fruit flies are present initially and 300 are present after 10 days, how many will be present after 15 days? (10%)
8. Find the area of the region bounded above by the semicircle $y = (4-x^2)^{1/2}$, below by the x -axis, and on the left by the line $x = -1$. (10%)
9. A workplace is represented as a simple box, with a single process generating a given type of contaminant at a mass rate G . The volume of the room is V and air is being removed with the general exhaust ventilation system at volumetric rate Q . No replacement-air system is shown, so it is assumed that the natural infiltration is providing the replacement air. Assuming: (1) There is perfect mixing in the room, (2) G is constant, (3) The dilution air contains negligible amount of contaminant, (4) The contaminant is introduced into the room solely through process generation, and (5) The contaminant is removed from the workplace solely through the general exhaust ventilation system. Please calculate the airborne concentration C of the given contaminant as a function of time t , if the initial concentration of the workplace is assumed to be zero. What is the maximum concentration C_{max} of the workplace environment? (20%)