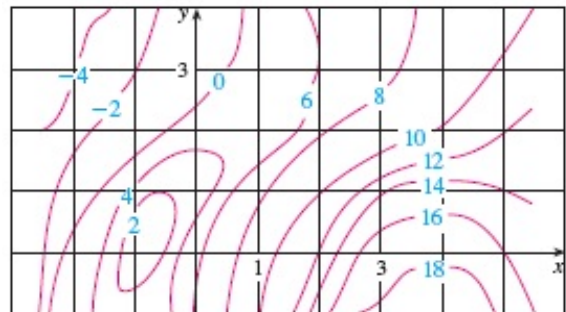**Test Instructions:**
    Write complete solutions to the following problems. Be sure to provide all the necessary steps to support your answers. . **Box All Answers**.

1.   Find an equation of the tangent plane and the normal line to the given surface at the specified point.

   $z = e^{x^2 - y^2}$, at $(1, -1, 1)$

2.   A contour map is given for a function f.

a.   Use it to estimate $f_x(2,1)$, and $f_y(2,1)$

b.   Use Linear approximation to estimate the value of f at $(2.2, 1.3)$

3.   The dimensions of a closed rectangular box are measured x, y and z as 100 cm, 70 cm, and 30 cm, respectively, with a possible error of 0.2 cm in each dimension.
The surface area and the volume of the box is given by the equations
$S(x,y,z)=2xy+2xz+2yz, \ V(x,y,z)=xyz$.

a.   Find the linear approximation of S at the point (96, 69, 29).

b.   Suppose the box has been measured with a ruler that has one centimeter gradation, find the actual maximum error in measuring the surface of the box.

c.   Find $L(101,71,31)-L(100,70,30)$

d.   Use differentials to estimate the error in the measurement of the surface area of the box.

e.   Compare the answers of parts c to d and the d to b. What do you conclude?

f.   A coat of paint of thickness 0.0002 cm is applied to the exterior surface of the box. Use differentials to estimate the amount of the paint needed.