1) A mass distribution occupies the 3D region which is enclosed by the surfaces $z = x^2 + y^2$, $z = 0$ and $x^2 + y^2 = 4$. If the mass density function is $\delta = x^2 + y^2 + z^2$ units of mass/unit volume, calculate the total mass.
(20) 2) A mass distribution occupies the 3D region which is above the surface $z = \sqrt{x^2 + y^2}$ and inside the sphere $x^2 + y^2 + z^2 = 9$. If the mass density function is $\delta = \frac{1}{z}$ units of mass/unit volume use a triple integral in spherical coordinates to calculate the total mass.
(15) 3) Calculate the surface area of the parametrized surface $x = 2t^2$, 
$y = t$, $z = st$, $0 \leq s \leq 3$, $0 \leq t \leq 2$. 
The force field \( \vec{F} = xy \vec{i} + x^2 \vec{j} \) acts on an object as it moves in the plane. Calculate the work done by \( \vec{F} \) for each of the following motions.

(a) The object moves from \((0, 0)\) to \((2, 1)\) along the line \(x = 2y\).

(b) The object moves from \((0, 0)\) to \((2, 1)\) by first going along \(x = y^2\) from \((0, 0)\) to \((1, 1)\) and then along the line segment from \((1, 1)\) to \((2, 1)\).
(10) 5) Show that the force field

$$\vec{F} = \left(y + 2x + \frac{y}{x^2}\right)\hat{i} + \left(x + 1 - \frac{1}{x}\right)\hat{j}$$

is conservative in the region $x > 0$ by finding a potential function for it. Now use this potential function to find the work done by $\vec{F}$ as it acts on an object which moves along a path in the right half plane from $(1, 1)$ to $(2, 4)$. 
6) Use Green’s theorem to evaluate the line integral
\[ \int_C \left( y^2 + ye^{xy} \right) dx + \left( 4xy + xe^{xy} \right) dy \]
where \( C \) is the closed path made up of the sides of the triangle with vertices \((0, 0), (1, 1)\) and \((2, 0)\) directed counterclockwise.