Problem 1: Sketch the following curves.

1. $\vec{r}(t) = t\,\hat{i} + (2-t)\,\hat{j} + (1+t)\,\hat{k}$, $t \leq 1$
2. $\vec{r}(t) = (2+t)\,\hat{i} + (1+t)\,\hat{j} + (1-t)\,\hat{k}$, $1 \leq t \leq 2$.

Problem 2: Sketch the graphs of the following functions of two variables. Use the knowledge quadric surfaces if needed.

1. $f(x,y) = x^2$
2. $f(x,y) = 10 - 4x - 5y$
3. $f(x,y) = 2 - x^2 - y^2$
4. $f(x,y) = \sqrt{4x^2 + y^2}$
5. $f(x,y) = \sqrt{4 - 4x^2 - y^2}$

Problem 3: Sketch the level curves (also called contour curves) of the following functions of two variables for the level values $k = -2, -1, 0, 1, 2$.

1. $f(x,y) = \sqrt{x} + y$
2. $f(x,y) = xy$
3. $f(x,y) = x^2 - y^2$
4. $f(x,y) = ye^x$
5. $f(x,y) = y - \tan^{-1}(x)$

Problem 4: Convert the following Cartesian coordinates into cylindrical and spherical coordinates.

$$(-1,1,1) \quad (-\sqrt{2},\sqrt{2},1) \quad (1,0,\sqrt{3}) \quad (\sqrt{3},-1,2\sqrt{3})$$

Problem 5: Convert the following cylinderical coordinates into Cartesian and Spherical coordinates.

$$(4,\pi/3,-2) \quad (2,-\pi/2,1) \quad (\sqrt{2},3\pi/4,2)$$

Problem 6: Convert the following spherical coordinates into Cartesian and cylinderical coordinates.

$$(6,\pi/3,\pi/6) \quad (3,\pi/2,3\pi/4) \quad (2,\pi/2,\pi/2)$$

Problem 7: Describe and sketch the surface whose equation in cylinderical coordinates is the following

1. $r = z$
2. $r = 2$
3. $\theta = \pi/6$

4. $r^2 + z^2 = 4$
5. $r = 2\sin\theta$

Problem 8: Describe and sketch the surface whose equation in spherical coordinates is the following

1. $\rho\cos\phi = 1$
2. $\rho = \cos\phi$
3. $\phi = \pi/3$
4. $\rho = \cos\theta\cos\phi$
5. $\theta = \pi$

Problem 9: Write following Cartesian equations in cylinderical and spherical coordinates.

1. $x^2 - x + y^2 + z^2 = 1$
2. $z = x^2 - y^2$
3. $z = x^2 + y^2$
4. $x^2 - y^2 - z^2 = 1$

Problem 10: Identify and Sketch the surfaces with the following parametric/vector equations.

1. $\vec{r}\,(u, v) = (u + v)\,\hat{i} + (3 - v)\,\hat{j} + (1 + 4u + 5v)\,\hat{k}$
2. $x = u^2\,,\ y = u\cos v\,,\ z = u\sin v$
3. $x = (\cos t)(\sec s)\,,\ y = 3\,(\sin t)(\sec s)\,,\ z = \tan s$
4. $x = 3\,\cos t\,,\ y = s\,,\ z = \sin t\,,\ -1 \le s \le 1.$

Problem 11: Find the parametric equation for the following surfaces

1. The plane through the origin that contains the vectors $\hat{i} - \hat{j}$ and $\hat{j} - \hat{k}$.
2. The part of the hyperboloid $4x^2 - 4y^2 - z^2 = 4$ that lies in front of the yz-plane.
3. The part of the ellipsoid $x^2 + 2y^2 + 3z^2 = 1$ that lies to the left of the xz-plane.
4. The part of the sphere $x^2 + y^2 + z^2 = 4$ that lies above the cone $z = \sqrt{x^2 + y^2}$.
5. The part of the cylinder $x^2 + z^2 = 9$ that lies above the xy-plane and between the planes $y = -4$ and $y = 4$.