Name:

Score: \_\_\_\_\_

**Instructions:** You must show supporting work to receive full and partial credits. No text book, notes, formula sheets allowed.

- **1(10pts)** Three points in the space are given: P(0,1,2), Q(1,2,3), R(-1,-1,1).
  - (a) Find the angle between the vectors  $\vec{PQ}, \vec{PR}$ .

(b) Find the projection of vector  $\vec{PR}$  on  $\vec{PQ}$ :  $\vec{proj}_{\vec{PQ}}\vec{PR}$ .

**2(6pts)** Find the equation of the plane that goes through the point (1,0,-2) and is parallel to another plane: x + 2y + 3z + 4 = 0.

**3(6pts)** Sketch the surface of the equation  $x + y^2 + 2z^2 - 1 = 0$ , showing a few appropriate traces.

- **4(18pts)** Three points in the space are given: P(0,1,2), Q(2,0,1), R(-1,-1,1).
  - (a) Find the equation of the plane containing the points.

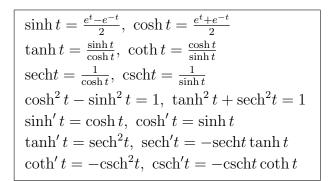
- (b) Find the area of the triangle with these points as its vertexes.
- (c) Find the parametric equations of the line through point P and perpendicular to the plane.

**5(7pts)** The velocity of a moving particle is given as  $\vec{v}(t) = \langle t, 2t, e^{2t} \rangle$ . Find its position  $\vec{r}(t)$  if  $\vec{r}(0) = \langle 0, 1, 1 \rangle$ .

- 6(14pts) Find the limit if exists, or show it does not exist by the 2-path rule.
  - (a)  $\lim_{(x,y)\to(0,0)} \frac{\cos(xy)}{1+x^2+y^2}$
  - (b)  $\lim_{(x,y)\to(0,0)} \frac{xy}{2x^2+y^3}$

**7(15pts)** Consider the curve given by  $\vec{r}(t) = \langle t, \cosh t \rangle$ .

(a) Find the unit tangent vector  $\vec{T}(t)$ .



(b) Find the unit principal normal vector  $\vec{N}(t)$ .

(c) Find the curvature.

**8(6pts)** Find the distance from the point (1,1,2) to the line which goes through (1,0,1) and (3,2,-1).

| 9(18pts) | At an instance the following are given for a particle in motion: The acceleration $\vec{a} = (0, 3, 4)$ , the velocity $\vec{v} = (-1, 0, 1)$ . Find the following: ( <i>Hint</i> : use the relation $\vec{a} = a_T \vec{T} + a_N \vec{N}$ .)  (a) The speed $\frac{ds}{dt}$ at the instance. |
|----------|---|
|          | (b) The tangential component of the acceleration $a_T$ at the instance.   |
|          | (c) The normal component of the acceleration $a_N$ at the instance.   |
|          | (d) The trajectory's curvature $\kappa$ at the instance.  |
|          | (d) The principal normal unit vector $\vec{N}$ at the instance.   |
|          | (e) The binormal unit vector $\vec{B}$ at the instance.   |