Sl No	Name	Roll No	Assignment	Marks	Remarks
1	Manish Kumar	EEB17036	Fig. 1 b) from "New family of 4-D hyperchaotic and chaotic systems with quadric surfaces of equilibria"	20	1. Overall good. (*note: it is not a PMSG model which you mentioned in your code*!) 2. Explain the following lines of your code (why negative only for Xn): X_total=[Xn -Xn]; Y_total=[Yn Yn]; Z_total=[Zn Zn]; 3. Can you explain how the equilibrium points you have calculated are in the form of the general equation/expression of a spheroid?
2	Sanjay Barman	EEB17026			
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4	Aniket Raj	EEB17031			
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1. **Explain the following lines of your code (why negative only for Xn):**

   X_total= [Xn -Xn];

   Y_total= [Yn Yn];

   Z_total= [Zn Zn];

   Ans: Because if we don't take negative of Xn we would have half spheroid.

   As we have seen equilibrium point has been acquired from approximated solution

   ```
   E=[x1val(3,:);x2val(3,:);x3val(3,:);x4val(3,:)];
   ```

   Where X1val having multiple equation, here 3rd and 8th equation (the red one) in box below both equations have the same magnitude with opposite sign so we have taken 3rd equation in equilibrium point. After calculating the points from E we have added another calculated point with negative sign.

   e.g. X_total= [Xn -Xn] (here there is negative sign because 3rd and 8th equation in box below have opposite sign with same magnitude)

```
>> x1val

x1val =

-1.0*(1.0 - 2.0*z^2)^(1/2)

(-1.0*(z - 1.0)*(z + 1.0))^(1/2)

(- 2.0*z^2 - 1.0*z1^2 + 1.0)^(1/2)

-0.47140452079103168293389624140323*(- 9.0*z^2 - 8.0)^(1/2)

0.47140452079103168293389624140323*(- 9.0*z^2 - 8.0)^(1/2)

-1.0*(-1.0*(z - 1.0)*(z + 1.0))^(1/2)

(1.0 - 2.0*z^2)^(1/2)

-1.0*(- 2.0*z^2 - 1.0*z1^2 + 1.0)^(1/2)
```

Just like previous, here also 3rd and 8th equation in box below have same magnitude with same sign, we have only considered one of the them, after calculating the points from E we added second z1.
e.g. Y_total= [Yn Yn] (here there is no negative sign because in x2val value both equation 3rd and 8th are same)

```
>> x2val

   x2val =

   0

   z

   z1

   -1.666666666666666666666666666667

   -1.666666666666666666666666666667

   z

   0

   z1
```

Similarly, for Z_total= [Zn Zn];

2. Can you explain how the equilibrium points you have calculated are in the form of the general equation/expression of a spheroid?

Ans: This is our equilibrium point

```
E =

(- 2.0*z^2 - 1.0*z1^2 + 1.0) ^ (1/2)

z1

0

z
```

let,

x1= (- 2.0*z^2 - 1.0*z1^2 + 1.0) ^ (1/2) -(1)

x2= z1 -(2)

x3= 0 -(3)

x4= z -(4)

Squaring both side in equation 1,2 & 3.

$$x_1{}^2 = (-2.0 * z^2 - 1.0 * z_1{}^2 + 1.0) \quad \text{-(5)}$$

$$x_2{}^2 = z_1{}^2 \quad \text{-(6)}$$

$$x_4{}^2 = z^2 \quad \text{-(7)}$$

Now, substituting the value of $z_1{}^2$ and z^2 from equation 6 & 7 into the equation 5.

We have,

$$x_1{}^2 + x_2{}^2 + \frac{x_4{}^2}{1/2} = 1, \quad x_3 = 0$$

This is the expression of a spheroid and is similar to the spheroid equation given in the research paper.

QS2 $\dot{x}_1 = x_3\ \dot{x}_2 = -x_3(hx_2 + dx_2^2 + x_1x_3)\dot{x}_3 = \frac{x_1^2}{a^2} + \frac{x_2^2}{a^2} + \frac{x_4^2}{b^2} - 1\ \dot{x}_4 = -gx_3x_4\ h = 5,\ d = 3,\ g = 1,\ a = 1,\ 1/b^2 = 2$ $\left(\frac{x_1^2}{a^2} + \frac{x_2^2}{a^2} + \frac{x_4^2}{b^2} = 1, x_3 = 0\right)$ Spheroid

Thank you