Lecture 19 Review

Gaussian elimination.

LU decomposition
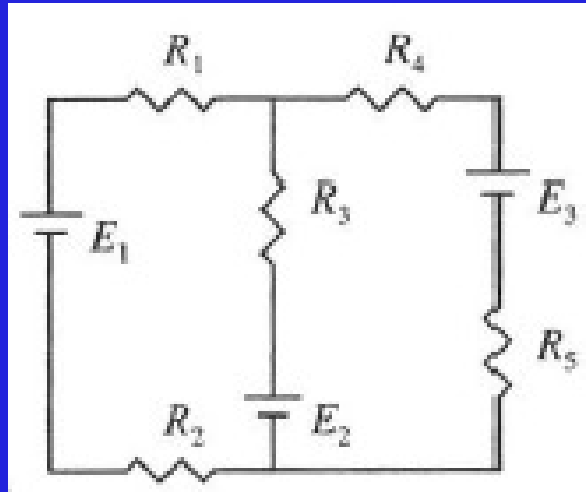
`octave` intro

Finding eigenvalues and eigenvectors

`octave` calisthenics

Intro to solving ODEs w/ `octave`

Octave + Kirchhoff's Rules Review

R1 = R2 = 1Ω   E1 = 2V

R3 = R4 = 2Ω   E3 = 5V

R5 = 5Ω   E2 = 10V

Find I in all legs.

Planetary Orbits via `octave`

How to solve 2nd order ODEs via `octave`.

Example: $\vec{F} = -\frac{GMm}{r^2}\hat{r}$ What is trajectory of a body due to F?

$$a_x = \ddot{x} = -\frac{GMx}{(x^2+y^2)^{3/2}}$$

$$a_y = \ddot{y} = -\frac{GMy}{(x^2+y^2)^{3/2}}$$

Recall: $\frac{ds}{dt} = f(s,t)$ `octave` knows show to solve this ODE

column vector:

math: $s \equiv \begin{pmatrix} x \\ v_x \\ y \\ v_y \end{pmatrix}$

physics: $\frac{d}{dt}\begin{pmatrix} x \\ v_x \\ y \\ v_y \end{pmatrix} = \begin{pmatrix} v_x \\ -\frac{GMx}{(x^2+y^2)^{3/2}} \\ v_y \\ -\frac{GMy}{(x^2+y^2)^{3/2}} \end{pmatrix}$

2nd order ODE Solutions via `octave`

kepler.m

```
# function kepler useful for solving
# planetary motion around sun.

        function xdot = kepler(x,t)
            xdot = zeros(4,1);
            a = 39.5;
            xdot(1) = x(2);
xdot(2) = -a*x(1)/((x(1))**2 + (x(3))**2)^1.5;
            xdot(3) = x(4);
xdot(4) = -a*x(3)/((x(1))**2 + (x(3))**2)^1.5;

        endfunction
```

inside `octave`:

```
source "kepler.m"
X0 = [1;0;0;2*pi];
t = linspace(0,2,100);
y = lsode("kepler", x0, t);

plot(t,y)

save orbit.dat y
```

orbit.dat from octave

examine contents of orbit.dat

```
linux[22]> head -10  orbit.dat
```

inside gnuplot: plot y versus x.

What do you expect?

What do you see?

Return of the van der Pol equation

Lab exercise:

$$\ddot{x} + \mu(x^2 - a^2)\dot{x} + \omega_0^2 x = 0$$

Recall similarity to damped SHM: $\ddot{x} + 2\beta\dot{x} + \omega_0^2 x = 0$ $(\beta > 0)$

Set a = 1, ω_0 = 1, μ = 0.05

Plot dx/dt versus x.

What do you expect?

What do you see?

Summary

Solving 2nd order ODEs w/ `octave`

Don't suffer in silence. Scream for help!!!