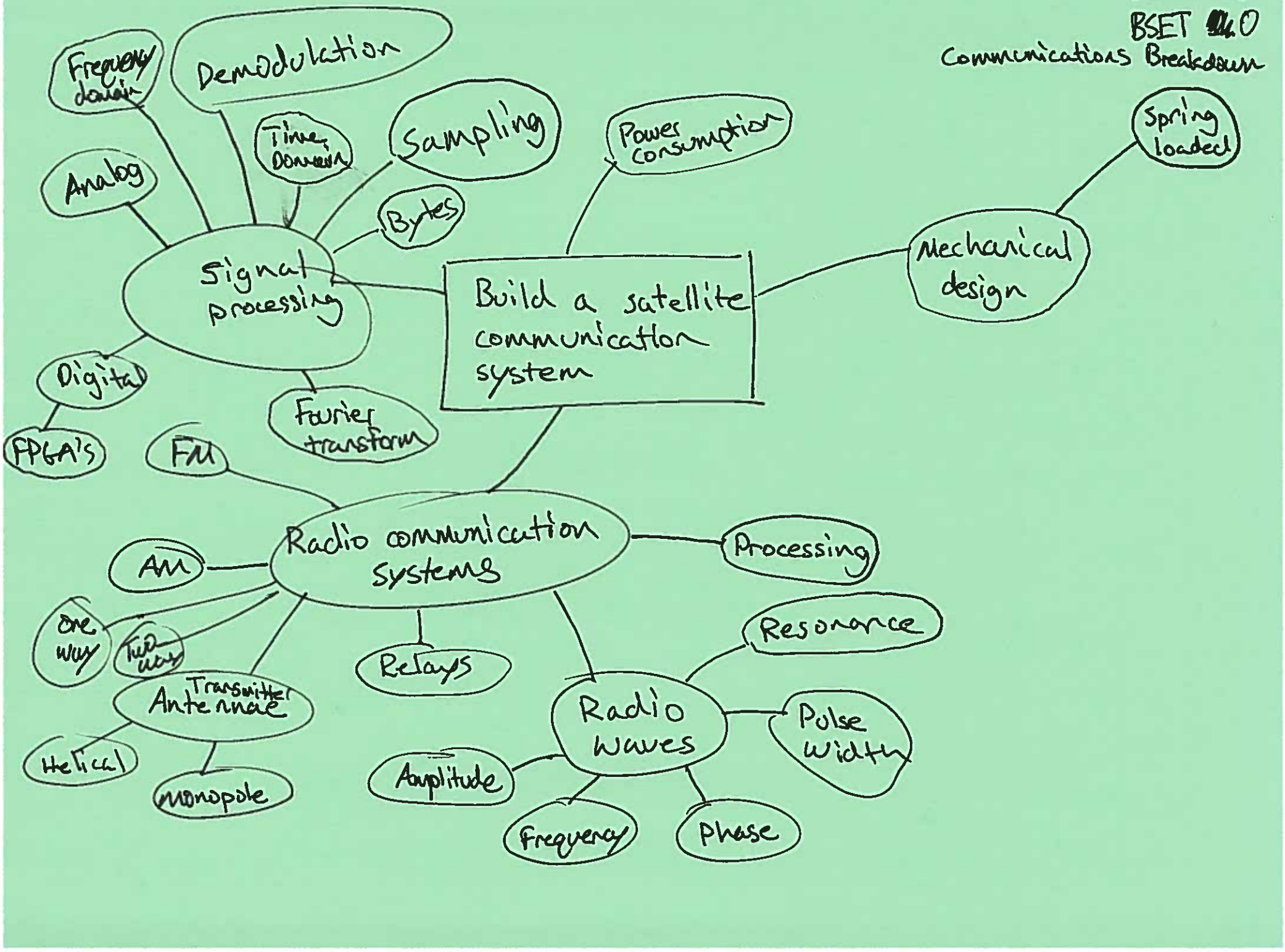
Nathan
BSET [redacted].0
Communications Breakdown



BSET #0
Communications
Breakdown

Signal processing

- Time domain
- Frequency domain
- Sampling
- Bytes
- Sampling

Radio Communications System

- ~~Frequency~~
- Antennae
- AM/FM
- One way/Two way
- ~~Phase~~
- Frequency / Amplitude, phase, pulse width, resonance

QEA BSET #1
Modsim
Questions

(1)

Flow in

2.1 m

45% precipitation = .945
55% aquifer = 1.155

Flow out

2.1

26% evaporation = .5460
74% seepage = 1.554

How long to dry out if precipitation 25% below normal

prec = .945 * .75 = .7087

Flow in − Flow out = $\frac{-.2362\,m}{year}$

$12.9m \mp .2362mx = 0$

$\mp .236L\,x = -12.9$

$x = \frac{12.9}{.2362}$

$x = 54.6147$

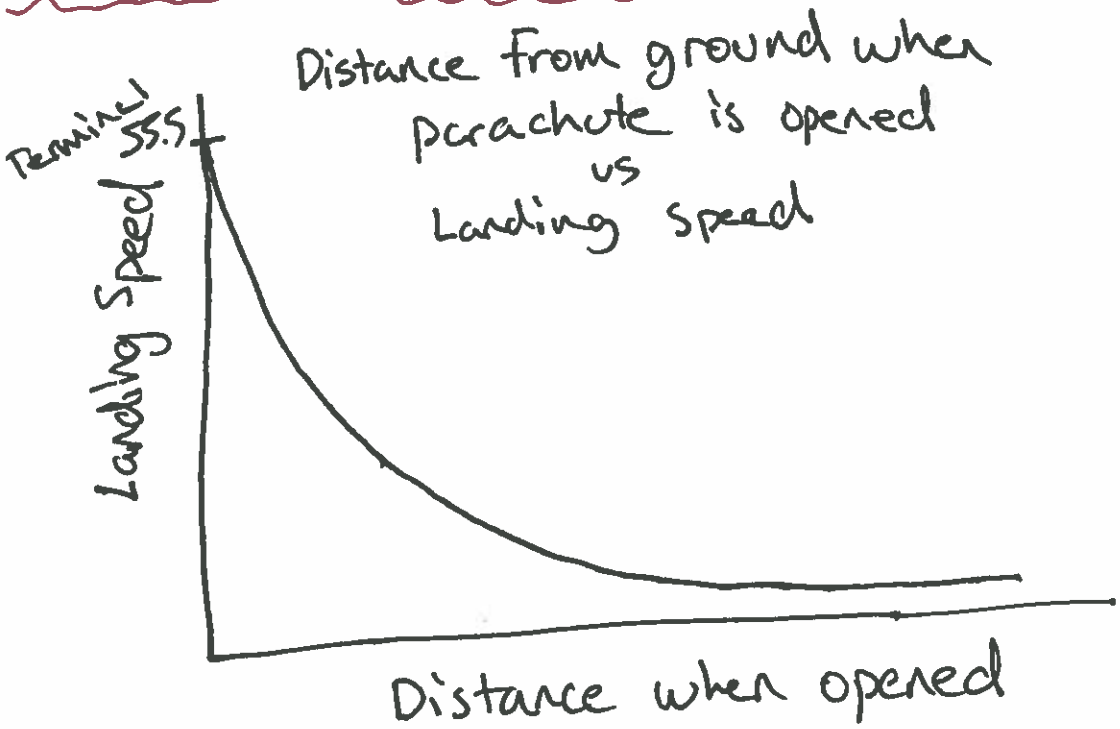
QEA
BSET #D
MODSIM

(2)

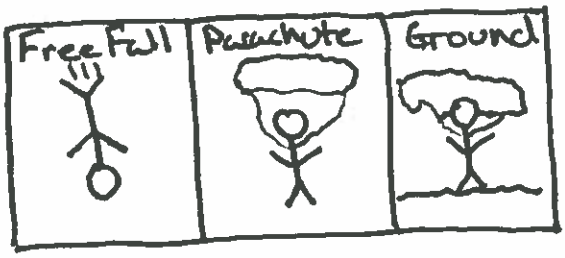
Top speed = terminal velocity

so, starting (HIGH) altitude is not important

Terminal velocity for human = 55.5 m/s



Assume parachute is immediately ~~in full~~ opened



Position $\Rightarrow$

Velocity $\Rightarrow \dot{x} = V$

Acceleration $\Rightarrow \dot{V} =$ ~~gravity~~ $\text{AirRes}_{\text{para}} + \text{AirRes}_{\text{person}} - \text{grav}$

$$\dot{x} = V$$

$$\dot{V} = \alpha V^2 + \beta V^2 - g$$

BSET 40

MODSIM QUESTIONS

(3)

$$\dot{X} = V$$

$$\dot{V} = -\alpha X - \beta V^2$$

(a)

$\dot{V} = \frac{m}{s^2}$ $\quad \alpha X = \frac{1}{s^2} m$ $\quad \beta V^2 = \frac{1}{m} \frac{m^2}{s^2}$

$\alpha = \frac{1}{s^2}$ $\quad \beta = \frac{1}{m}$

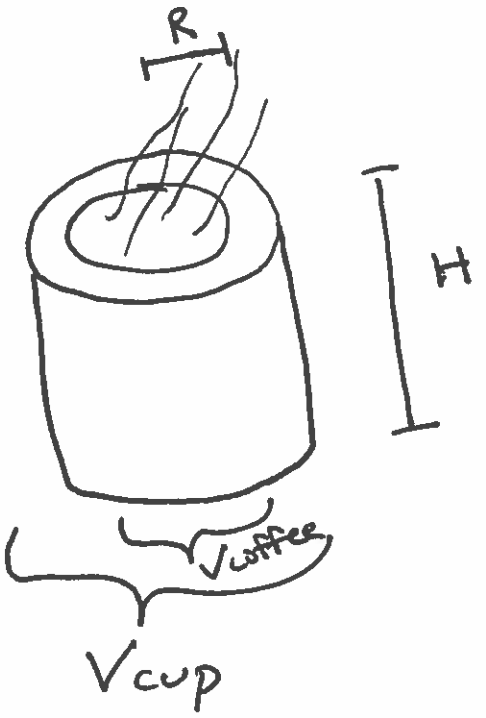
(b) ~~Code Image~~

~~CODE : Modsim 3.m~~

~~PLOT : Modsim 3.pdf~~

QEA
MODSIM
QUESTIONS

(4)



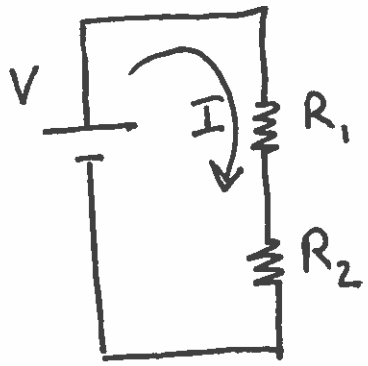
Energy Coffee = Temp Coffee · Specific Heat coffee

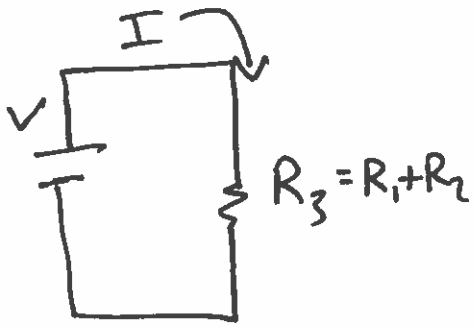
$$\frac{dE}{dt}_{coffee} = \text{Loss conduction}$$

$$\frac{dE}{dt} = -\frac{\text{mugCond} \cdot \text{mugArea}}{\text{mug Thickness}} \cdot (\text{Temp Coffee} - \text{Temp Room})$$

QEA
ISIM
QUESTIONS

① $V = 12V$
$R_1 = 10k\Omega$
$R_2 = 20k\Omega$



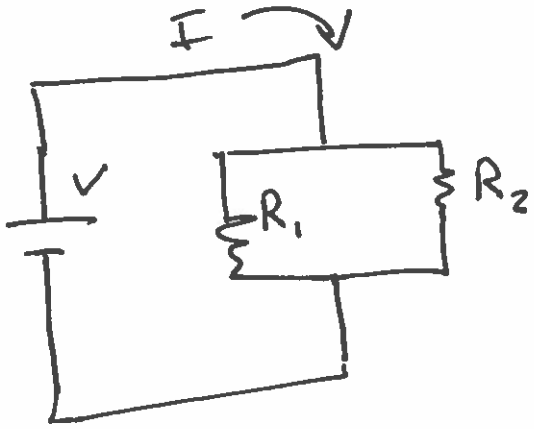


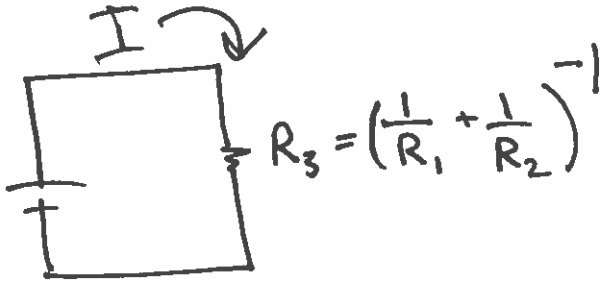
$R_3 = 30k\Omega$

$V = IR$

$12v = I\ 30k\Omega$

$I = .4$ mA





$R_3 = \left(\frac{2}{20k} + \frac{1}{20k}\right)^{-1}$

$= \left(\frac{3}{20k}\right)^{-1}$

$= \frac{20k}{3}$

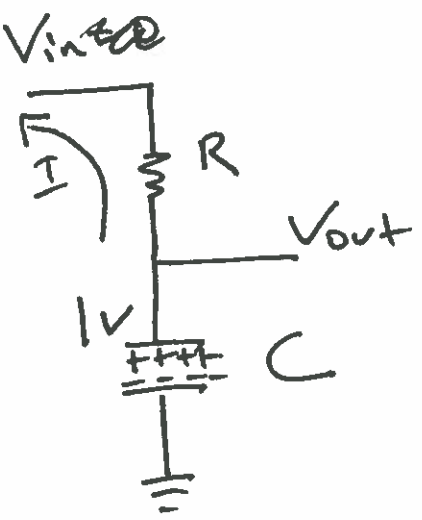
$R_3 = 6.67k\Omega$

$12V = I\ 6.67k\Omega$

$I = 1.8mA$

QEA-ISIM
BSET-0

(2)



$I = I_R = I_C$

$V_{in} = 0$

$V_{out_0} = 1$

$R = 10\,k\Omega$

$C = 1\,\mu F$

Resistor

$V_R = IR$

Capacitor

$I = C\frac{dV}{dt}$

$Q = CV$

$V_c = \frac{Q}{C}$

$I = -\frac{dQ}{dt}$

Kirchoff

$V_c - V_R = 0$

$\frac{Q}{C} - IR = 0$

$\frac{Q}{C} - \left(-\frac{dQ}{dt}\right)R = 0$

$\int_0^t \frac{-dt}{RC} = \int_{Q_0}^{q} \frac{dQ}{Q}$

$\frac{-t}{RC} = \ln(q) - \ln(Q_0)$

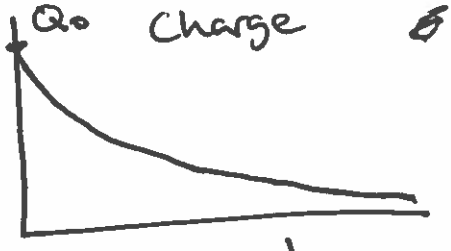
$\frac{-t}{RC} = \ln\left(\frac{q}{Q_0}\right)$

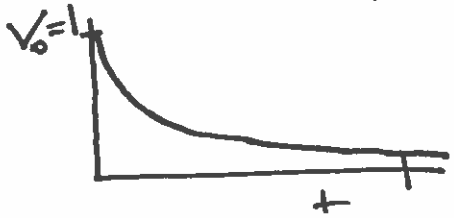
$e^{\frac{-t}{RC}} = e^{\ln\left(\frac{q}{Q_0}\right)}$

$e^{\frac{-t}{RC}} = \frac{q}{Q_0}$

$q = Q_0 e^{\frac{-t}{RC}}, \quad Q_0 = CV_0$

$V = V_0 e^{\frac{-t}{RC}}$





(3)

QEA
ISIM
QUESTION

$$\frac{(1+j)(3+j)(-2-j)}{(j)(3+4j)(5+j)}$$

Cartesian

$$\frac{(1+j)(3+j)(-2-j)}{(j)(3+4j)(5+j)}$$

$$\frac{(3+1j+3j+1)(-2-j)}{(3j-4)(5+j)}$$

$$\frac{(2+4j)(-2-j)}{(-4+3j)(5+j)}$$

$$\frac{(-4-2j-8j+4)}{(-20-4j+15j-3)}$$

$$\frac{-10j}{-23+11j}\left(\frac{11-23j}{11-23j}\right)$$

~~110 + 230j~~

$$\frac{-230-110j}{650} = \boxed{\frac{-11}{65}+\frac{23}{65}j}$$

$$= \boxed{-.169+.354j}$$

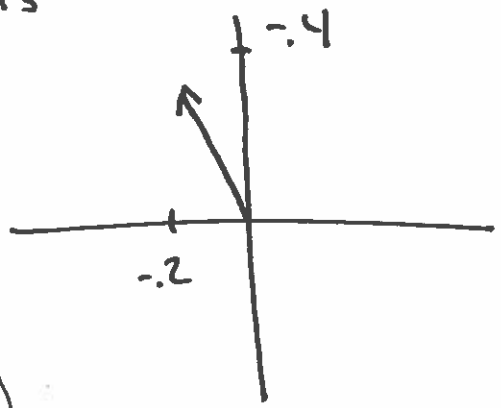
Polar

$$(\sqrt{2}\angle\frac{\pi}{4})(\sqrt{10}\angle \text{ArcTan}(\tfrac{1}{3}))$$

Arithmetic not worth my time.

Mathematica!

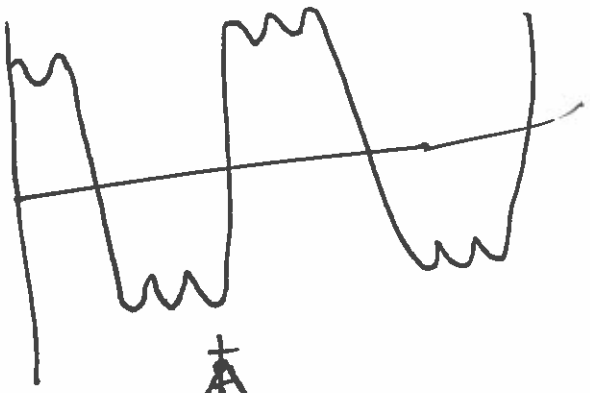
$$\sqrt{\frac{2}{13}}\, e^{j\left(\pi - \text{ArcTan}\left(\frac{23}{11}\right)\right)}$$



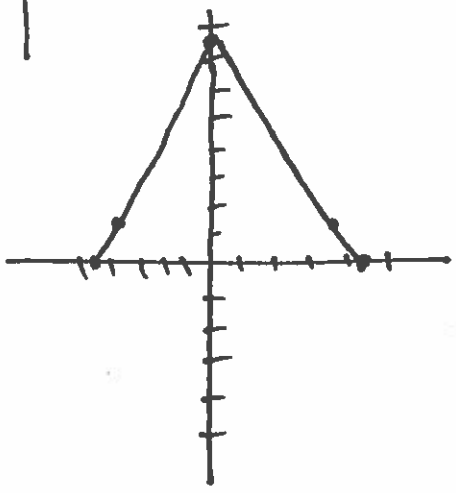
(4) $z(t) = e^{jt} - .3e^{3jt} + .2e^{j5t}$

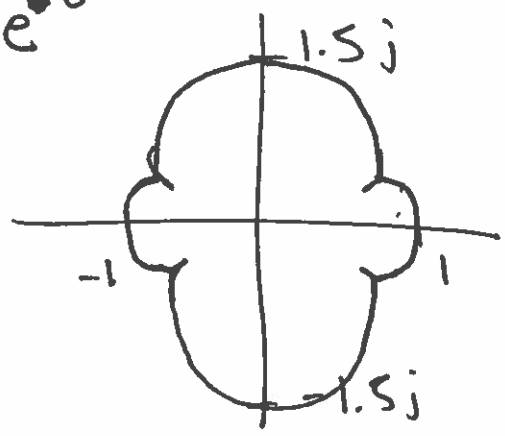
QEA
BSET 1
ISIM

t	z(t)	z(t)
0	$e^{0} - .3e^{0} + .2e^{0}$	$.9e^{j0}$
$\frac{\pi}{4}$	$e^{j\frac{\pi}{4}} - .3e^{j\frac{3\pi}{4}} + .2e^{j\frac{5\pi}{4}}$	$.8544e^{j.4206}$, $.78 + .353j$
$\frac{\pi}{2}$		



t	z(t)	z(t)
0	$.9 + 0j$	$.9e^{0j}$
$\frac{\pi}{4}$	$.77 + .35j$	$.855e^{j.427}$
$\frac{\pi}{2}$	$0 + 1.5j$	$1.5e^{j1.57}$
$\frac{3\pi}{4}$	$-.77 + .35j$	$.8544e^{2.715}$
π	$-.9 + 0j$	$-.9e^{j0}$





Mathematica

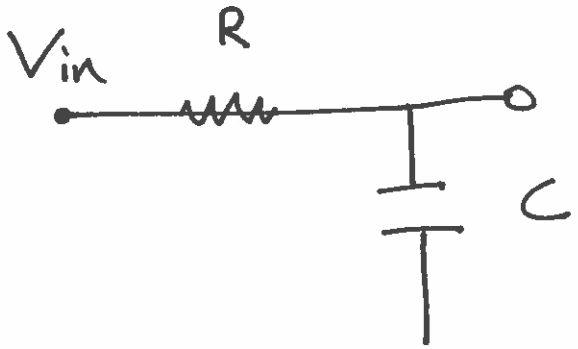
QEA
ISIM
QUESTIONS

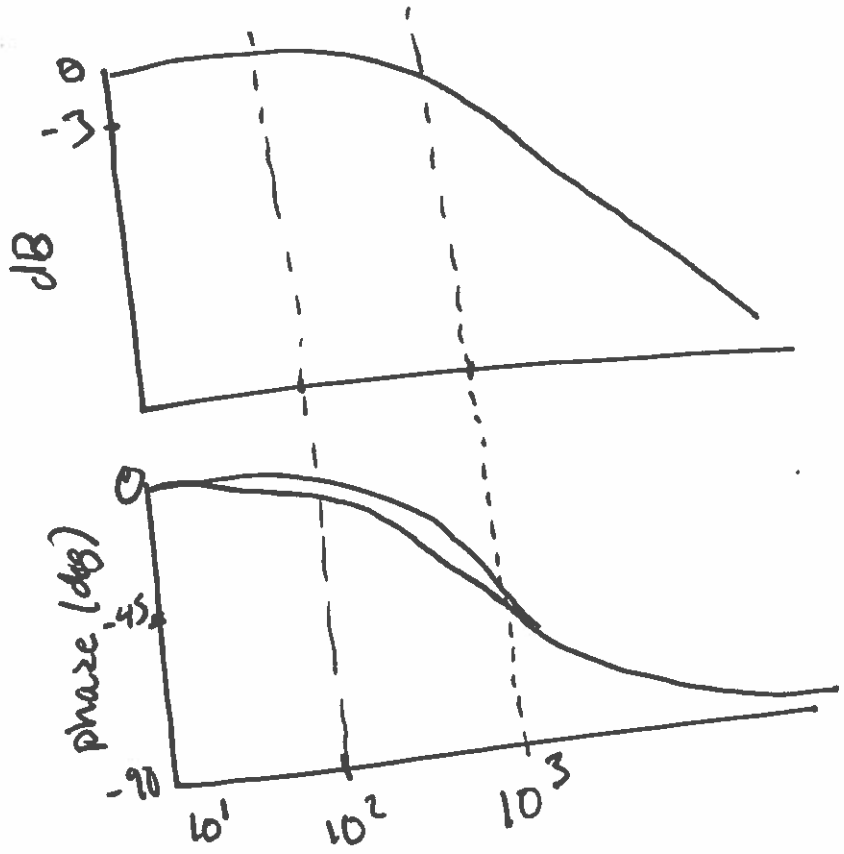
(5) Low pass

$$W_c = \frac{1}{RC} = 1\,kHz$$

$$R = 1000\,\Omega = 1\,k\Omega$$

$$C = \cancel{1000}\ 1\,\mu F$$

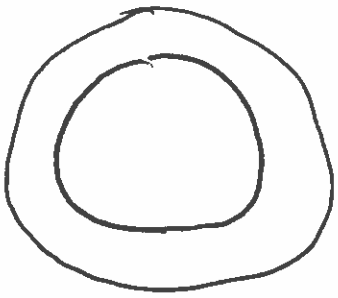


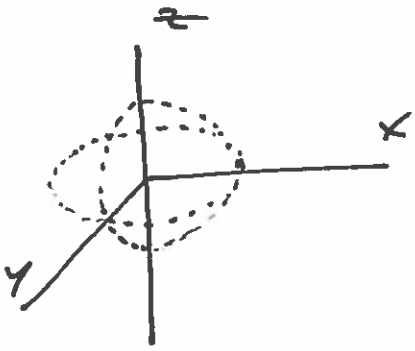


Integrate:

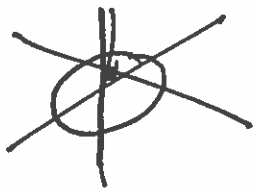
sphere, Hemisphere ~~$\frac{1}{4}$~~ & Plane, ~~$\frac{1}{8}$ sphere~~

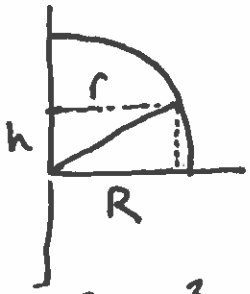
QEA
BSET #10
QEA REVIEW





Add up layers of circles





At $z=0$ largest circle

$r^2 = x^2 + y^2$

$R^2 = h^2 + r^2$

$\sqrt{R^2 - h^2} = r$

A circle at z height h will have ~~area~~ radius $\sqrt{R^2-h^2}$

smallest $h = -R$

largest $h = R$

Area at height $h \Rightarrow A = \pi r^2 = \pi\sqrt{R^2-h^2}^2 = \pi(R^2-h^2)$

$$\int_{-R}^{R} (\pi R^2 - \pi h^2)\, dh$$

$$\int_{-R}^{R} \pi R^2 dh - \int_{-R}^{R} \pi h^2 dh$$

$$\pi R^2 \int_{-R}^{R} dh - \pi \int_{-R}^{R} h^2 dh$$

$$\pi R^2 (R+R) - \pi \frac{h^3}{3}\Big|_{-R}^{R}$$

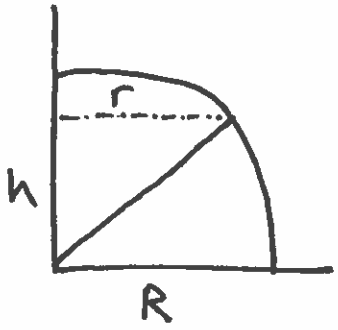
$$2\pi R^3 \quad -\pi\left(\frac{R^3}{3} - \frac{(-R)^3}{3}\right)$$

$$\frac{6}{3}\pi R^3 \quad -\frac{2\pi R^3}{3}$$

$$\frac{4}{3}\pi R^3$$

integrate half sphere

QEA BSET #0
QEA REVIEW



Area of circle at height h

$r = \sqrt{R^2+h^2}$

$A = \pi r^2 = \pi\sqrt{R^2+h^2}^2 = \pi(R^2+h^2)$

$$\int_0^R \pi(R^2+h^2)\,dh$$

$$\int_0^R \pi R^2 + h^2\,dh$$

$$\int_0^R \pi R^2\,dh + \int_0^R \pi h^2\,dh$$

$$\pi R^2\int_0^R dh + \pi\int_0^R h^2\,dh$$

$$\pi R^2(R) + \pi\left(\frac{R^3}{3}\right)$$

$$\frac{3}{3}\pi R^3 + \frac{\pi R^3}{3}$$

$\frac{4}{3}\pi R^3$ Strange. Got volume of regular sphere

MORE INTEGRALS

QEA BSET 0

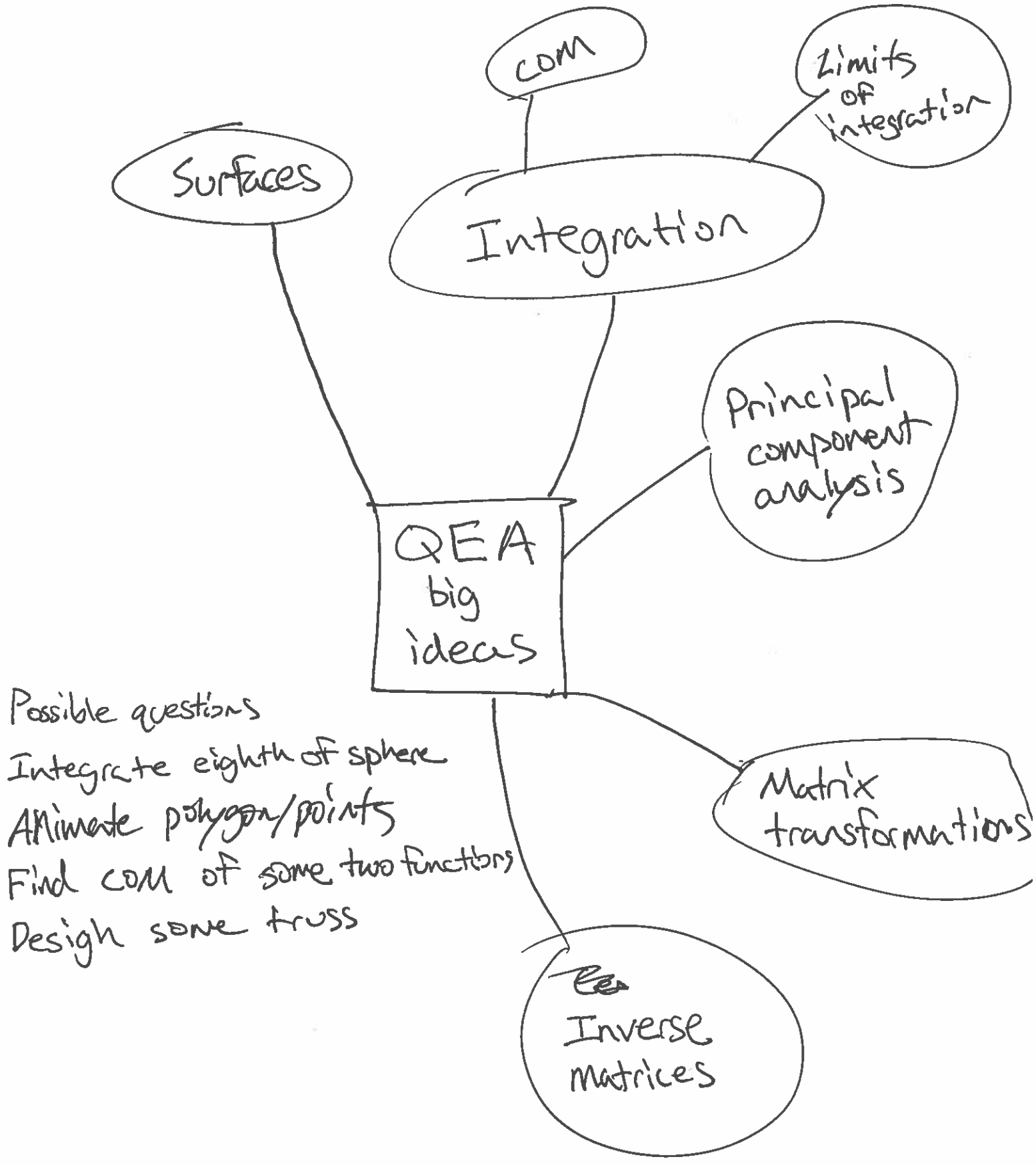
$\theta R z$

$0 \le \theta \le 2\pi$

$0 \le R \le r$

$0 \le z \le h$

$$\int_0^{2\pi} \int_0^{r} \int_0^{h} r \, dz \, dR \, d\theta$$



Possible questions

Integrate eighth of sphere

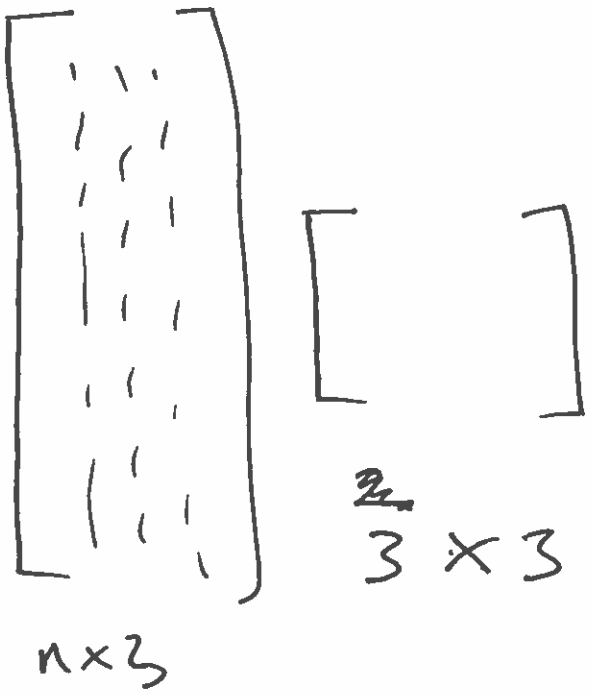
Animate polygon/points

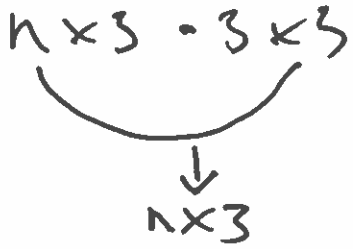
Find COM of some two functions

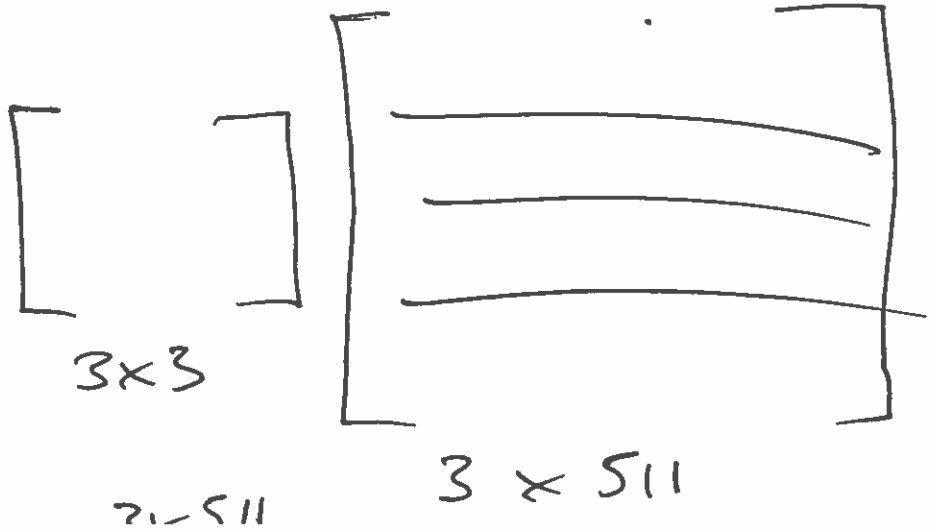
Design some truss

QEA-BSET
QEA-REVIEW

Animate points/polygon in Mathematica to remember matrix transformations







QEA BSET 0
DIFFERENCE EQUATIONS

(1)

$$X_{n+1} = 2X_n + 3$$

$$X_0 = X_0$$
$$X_1 = 2X_0 + 3$$
$$X_2 = 2(2X_0+3) + 3 = 4X_0 + 6$$
$$= 2^2 X_0 + 2^{n-1} \cdot 3$$

$$X_n = 2^n X_0 + 2^{n-1} \cdot 3$$

(2)

$$W_3 = \begin{pmatrix} 1 & 1 \\ 0 & 0 \end{pmatrix}\begin{pmatrix} X_3 \\ X_2 \end{pmatrix} = \begin{pmatrix} X_3+X_2 \\ X_3 \end{pmatrix} = \begin{pmatrix} X_4 \\ X_3 \end{pmatrix}$$

$2\times2 \quad 2\times1$
2×1

$$A = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix} \qquad \det(A-\lambda I) \neq 0$$

$$A-\lambda I = \begin{pmatrix} 1-\lambda & 1 \\ 1 & -\lambda \end{pmatrix}$$

$$\det(A-\lambda I) = 0 = (1-\lambda)(-\lambda) - (1)(1)$$

$$\lambda^2 - \lambda - 1 = 0$$

$$\lambda = \frac{1 \pm \sqrt{1+4}}{2}$$

$$\lambda_1 = \frac{1+\sqrt{5}}{2} \qquad \lambda_2 = \frac{1-\sqrt{5}}{2}$$

For $\lambda = \frac{1+\sqrt{5}}{2}$,

$$\begin{bmatrix} 1-\frac{1+\sqrt{5}}{2} & 1 \\ 1 & -\left(\frac{1-\sqrt{5}}{2}\right) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} \frac{1+\sqrt{5}}{2} & 1 \\ 1 & \frac{-1+\sqrt{5}}{2} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$V_1 = \begin{pmatrix} \frac{1+\sqrt{5}}{2} \\ 1 \end{pmatrix}$$

$$V_2 = \begin{pmatrix} \frac{1-\sqrt{5}}{2} \\ 1 \end{pmatrix}$$

(3) $w_n = c_1 \lambda_1^n v_1 + c_2 \lambda_2^n v_2$

(4)

DIFFERENCE EQUATIONS

$$w_n = c_1 \lambda_1^n v_1 + c_2 \lambda_2^n v_2$$

$$w_0 = \begin{pmatrix} 1 \\ 1 \end{pmatrix} = c_1 \left(\quad\right)^0 \begin{pmatrix} \frac{1+\sqrt{5}}{2} \\ 1 \end{pmatrix} + c_2 \left(\quad\right)^0 \begin{pmatrix} \frac{1-\sqrt{5}}{2} \\ 1 \end{pmatrix}$$

~~$\begin{pmatrix} 1 \\ 1 \end{pmatrix} = c_1$~~

$$1 = c_1 \frac{1+\sqrt{5}}{2} + c_2 \frac{1-\sqrt{5}}{2}$$

$$1 = c_1 + c_2$$

$$c_1 = \frac{1}{10}(5+\sqrt{5}), \quad c_2 = \frac{1}{10}(5-\sqrt{5})$$

$$w_n = \frac{1}{10}(5+\sqrt{5}) \left(\frac{1+\sqrt{5}}{2}\right)^n \begin{pmatrix} \frac{1+\sqrt{5}}{2} \\ 1 \end{pmatrix} + \frac{1}{10}(5-\sqrt{5}) \left(\frac{1-\sqrt{5}}{2}\right)^n \begin{pmatrix} \frac{1+\sqrt{5}}{2} \\ 1 \end{pmatrix}$$

$x_n =$ ~~$\frac{1}{10}(5+\sqrt{5})$~~

(5)

$$x_n = \frac{1}{10}(5+\sqrt{5}) \left(\frac{1+\sqrt{5}}{2}\right)^n (1) + \frac{1}{10}(5-\sqrt{5}) \left(\frac{1-\sqrt{5}}{2}\right)^n (1)$$

$$x_{100} = 5.73 \times 10^{20}$$