**Breakdown of Alan’s single compartment PLM**

%% PLM\_CD- Pump-Leak model - CD integration of Keener-Sneyd model

% p=pump rate., X = moles of impermeant ion, z = its charge

% R=RT/F, all concens in M, V in volts, dimensions dm.

% start at area & volume defined by radius, the volume is allowed to change

% but the area is fixed

%%%%%%%%%%%%%%%%%%%

clear, clc;

R=25.69\*1e-3; F=96485; % R (RT/F) in Volts, Faraday's constant C/mol

n=200; % # points to plot

Vm=1:n-1; K=1:n-1; Na=1:n-1; Cl=1:n-1; W=1:n-1; X=1:n-1; time=1:n-1;%create plotting arrays

time(1)=0; dt=1e-3; %zero time, dt time step, n number of points to plot

tt=10000; ts=tt/n; tit=round(tt/dt);% tt total time, tit - total # of steps

ton=0; toff=5000; %time when pump turned on & off

curr=-0\*5e-8; % current injected

gna=0.01\*0.1/F ; gk=0.3\*0.1/F ; gcl=0.2\*0.1/F; % conductances in mS/cm^2 conv to S/dm^2 (10^-3/10^-2)

p=0.5e-4/F; %pump rate (C/dm^2 s) div by F

ck=2;cna=3;%pump stoichiometry

rad=5; rad=rad\*1e-5; %(rad in um convert to dm)

w=(4/3)\*pi\*rad^3; %vol in liters

Ar=4\*pi\*rad^2; %area in dm^2

C=1e-4; %capacitance F/dm^2

FinvCAr=F/(C\*Ar); %(F/C\*Area)

Oso=300e-3; ko=3e-3; % set Oso

xo=0, zo=0; %xo is fixed ion outside and zo its charge

clo=(Oso-xo+zo\*xo)/2;% calc clo from charge and osmotic balance

nao=clo-ko-zo\*xo; % calc nao

x=50e-3; z=-1; MX=x\*w;% X CONCEN

cl=(Oso-2\*x)/2 , na=0.8\*(Oso-cl-x), k=0.2\*(Oso-cl-x), %INITIAL INTRA CONCs

ctr=1;t=0; % ctr counter for plotting points, t real time 5%%

sw=0;

x=MX/w;

V =FinvCAr\*w\*(na+k-cl+z\*x) % starting voltage

for i = 2:tit

if (toff>t)&&(tN>ton) sw=1 ;

else sw=0;

if t>toff sw=0;

end;

end;

V =FinvCAr\*w\*(na+k-cl+z\*x);

invw=1/w;

dna=-dt\*Ar\*invw\*(gna\*(V-R\*log(nao/na))+sw\*cna\*p);%increase in Na during time step dt

dk=-dt\*Ar\*invw\*(gk\*(V-R\*log(ko/k))-sw\*ck\*p+sw\*curr);

dcl=dt\*Ar\*invw\*(gcl\*(V+R\*log(clo/cl)));

na=na+dna; k=k+dk; cl=cl+dcl; % increment concentrations

Osi=na+k+cl+x; % intracellular osmolarity

w2=(w\*Osi)/Oso; % correct volume

na=(na\*w)/w2; k=(k\*w)/w2; cl=(cl\*w)/w2 ; x=(x\*w)/w2; % correct concens

w=w2;

if t>=ctr\*ts

Vm(ctr)=1000\*V; K(ctr)=1000\*k; Na(ctr)=1000\*na;

Cl(ctr)=1000\*cl; W(ctr)=100\*(1\*10^5)\*((3/(4\*pi)).\*w).^(1/3);X(ctr)=1000\*x; time(ctr)=t; ctr=ctr+1;

end

t=t+dt;

end

figure

subplot(2,1,1)

plot (time,K,'--k',time,Na,'-r', time,Cl,'-g',time,X,'-b')

legend('K','Na','Cl','X')

subplot(2,1,2);

plot(time,W);

legend('Rad(um x100)','Vm')