

$$v_{Na} = 115\text{mV}, \quad v_K = -12\text{mV}, \quad v_{Na} = 10.6\text{mV}, \quad C = 1\mu\text{Farad}/\text{cm}^2,$$

where " Ω " is one Ohm, the unit of resistance.

Non-dimensionalise with $v = v/v_{Na}$ and $\tau = t/[5\text{ms}]$, as $\tau_n(v) \sim O(5\text{ms})$, and we have

$$\begin{aligned} \epsilon \frac{dv}{d\tau} &= I_{ext} - g(v, n) \stackrel{\text{def}}{=} I_{ext} - [m_{\infty}^3(v)(0.85 - n)(v - 1) + \gamma_K n^4(v + v_K) + \gamma_L(v - v_L)] \\ \frac{dn}{d\tau} &= k(v, n) \stackrel{\text{def}}{=} \frac{1}{\tau_n^*(v)} [n_{\infty}(v) - n], \end{aligned} \quad (21)$$

with

$$\epsilon = \frac{C}{G_{Na}[5\text{ms}]} = 2 \times 10^{-3}, \quad \gamma_K = \frac{G_K}{G_{Na}} \sim 0.3, \quad \gamma_L = \frac{G_L}{G_{Na}} \sim 3 \times 10^{-3},$$

$$I_{ext} = \frac{I_{ext}}{G_{Na}v_{Na}}, \quad v_K = -\frac{v_K}{v_{Na}} \sim 0.1, \quad v_L = -\frac{v_L}{v_{Na}} \sim 0.1, \quad \tau_n^*(v) = \tau_n(v)/[5\text{ms}] \sim O(1).$$

We can now sketch the nullclines, and noting the different timescales of the membrane potential response to the gating variable response (as $\epsilon \ll 1$) we can consider the phase plane trajectories in terms of fast and slow dynamics.

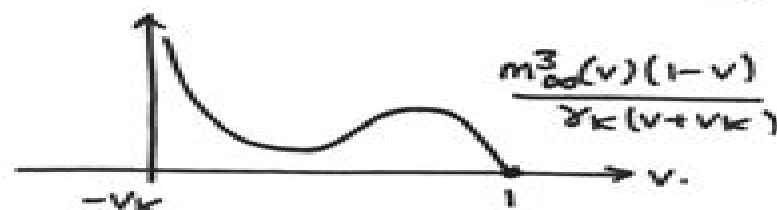
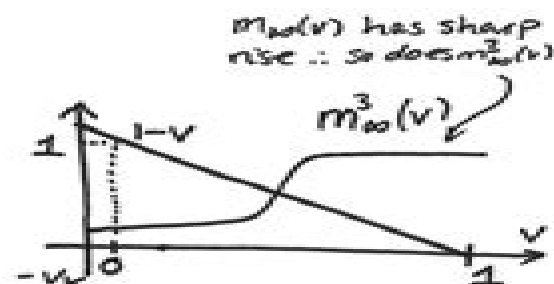
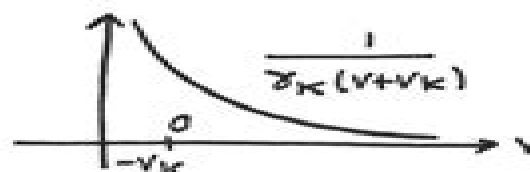
Plotting nullclines. $I_{ext} = 0$.

$$\begin{aligned} -\epsilon dv/d\tau = g &= m_{\infty}^3(v)(0.85 - n)(v - 1) + \gamma_K n^4(v + v_K) + \gamma_L(v - v_L) \\ dn/d\tau = k &= \frac{1}{\tau_n^*(v)} [n_{\infty}(v) - n] \end{aligned}$$

γ_L small: neglect this below.

v nullcline

$$\frac{n^4}{0.85 - n} = \frac{m_{\infty}^3(v)(1 - v)}{\gamma_K(v + v_K)}$$



Mathematical Physiology

Willy H. Verheye



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Applied Mathematical Models in Human Physiology Johnny T. Ottesen, Mette S. Olufsen, Jesper K. Larsen, 2004-02-01

This book introduces mathematicians to real applications from physiology Using mathematics to analyze physiological systems the authors discuss models reflecting current research in cardiovascular and pulmonary physiology In particular they present models describing blood flow in the heart and the cardiovascular system as well as the transport of oxygen and carbon dioxide through the respiratory system and a model for baroreceptor regulation This is the only book available that analyzes up to date models of the physiological system at several levels of detail both simple real time models that can be directly used in larger systems and more detailed reference models that show the underlying physiological mechanisms and provide parameters for and validation of simpler models The book also covers two dimensional modeling of the fluid dynamics in the heart and its ability to pump and includes a discussion of modeling wave propagation throughout the systemic arteries

Introduction to Mathematical Physiology and Biology, 1999 An Introduction to Mathematical Modeling in Physiology, Cell Biology, and Immunology James Sneyd, 2002 In many respects biology is the new frontier for applied mathematicians This book demonstrates the important role mathematics plays in the study of some biological problems It introduces mathematicians to the biological sciences and provides enough mathematics for bioscientists to appreciate the utility of the modelling approach The book presents a number of diverse topics such as neurophysiology cell biology immunology and human genetics It examines how research is done what mathematics is used what the outstanding questions are and how to enter the field Also given is a brief historical survey of each topic putting current research into perspective The book is suitable for mathematicians and biologists interested in mathematical methods in biology

Differential Equations for Studies in Computational Electrophysiology Karoline Horgmo Jæger, Aslak Tveito, 2023-05-27

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Mathematical Physiology; Blood Flow and Electrically Active Cells H. Melvin Lieberstein, 1973 Modeling Human Atrial Patho-Electrophysiology from Ion Channels to ECG - Substrates, Pharmacology, Vulnerability, and P-Waves Loewe, Axel, 2016-08-03 Half of the patients suffering from atrial fibrillation AF cannot be treated adequately today This book presents multi scale computational methods to advance our understanding of patho mechanisms to improve the diagnosis of

patients harboring an arrhythmogenic substrate and to tailor therapy The modeling pipeline ranges from ion channels on the subcellular level up to the ECG on the body surface The tailored therapeutic approaches carry the potential to reduce the burden of AF

Democratic Global Governance Irene Lyons Murphy, 2010-09-28 Democratic Global Governance is a component of Encyclopedia of Institutional and Infrastructural Resources in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias The theme on Democratic Global Governance relates the critical international issues of the post war era to the major decisions of the UN and its IGO network It is divided into two topics the first concerns global governance and the collective decision processes of the UN system while the second reviews and analyzes the impact of the nongovernmental sector as it has grown in strength and become part of a nascent global civil society This volume is aimed at the following five major target audiences University and College students Educators Professional practitioners Research personnel and Policy analysts managers and decision makers and NGOs

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