Use of any resources via smart phones or laptops is unfortunately illegal during this exam.

BYM 501E FUNDAMENTALS OF BIOMEDICAL ENGINEERING (14632)
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Midterm Examination 25 November 2019 12-14

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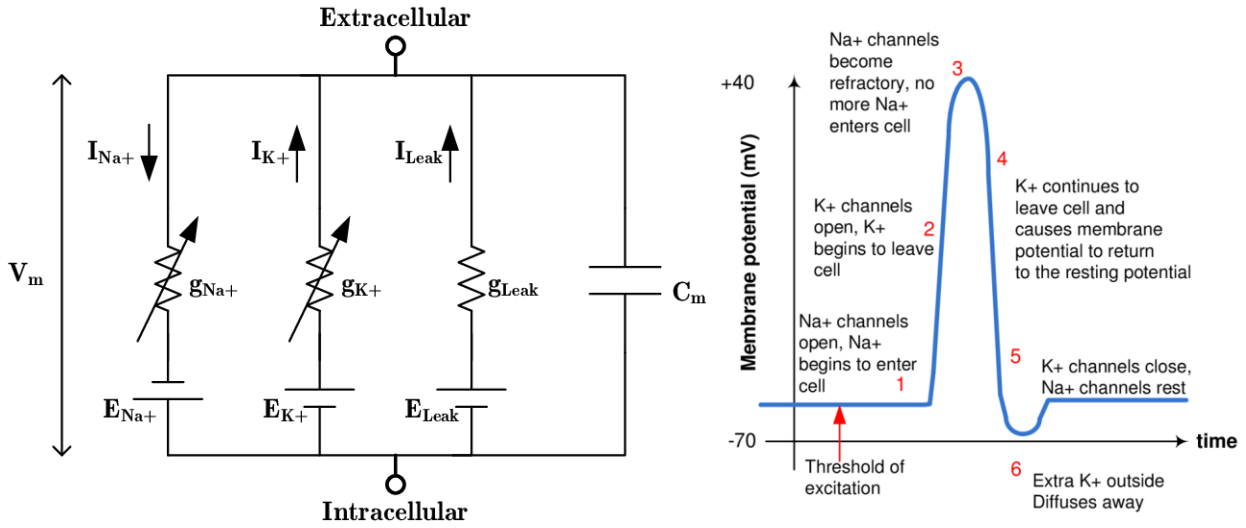
1. Define, compare and contrast the following terms in terms of biomedical measurements and instrumentation operation:
    a. invasive / non-invasive
    b. direct / indirect
    c. intra-corporeal / extra-corporeal (such as, intra-vascular / extra-vascular)
    d. real-time / delayed-time
    e. sampling / continuous operation

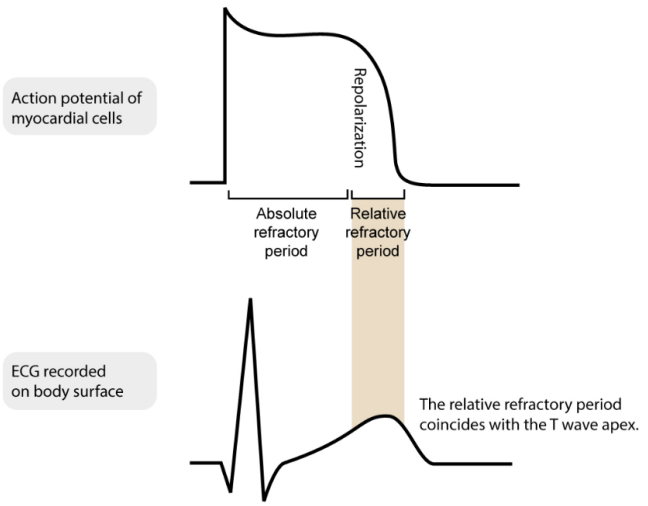
    and provide examples for each set of terms. (2x5 points)
2. Name and briefly explain
    a. major static (characteristics) of a biomedical measurement system. (6 points)
    b. the significance of dynamic properties when monitoring biological signals. (4 points)
3. The figures below illustrate the components of the Hodgkin-Huxley model and their roles in action potential. The capacitance C_m is the portrayal of the lipid bi-layer. The non-linear electrical conductances (g_{k+} and g_{Na+}) control the voltage-gated ion channels. The leakage channel is represented by the linear conductance (g_{Leak}). The equilibrium potential of each ion is given by E_{Na} , E_K and E_L. V_m is the transmembrane potential. Interpret how the non-linear electrical conductances change before, during and after the action potential. (10 points)



4. What instruments (signal generator, multimeter, oscilloscope, etc.) would you use and how would you design measurements to measure dynamic properties of a biomedical measurement system? Which important 3 properties would you measure? Why and how? (15 points)

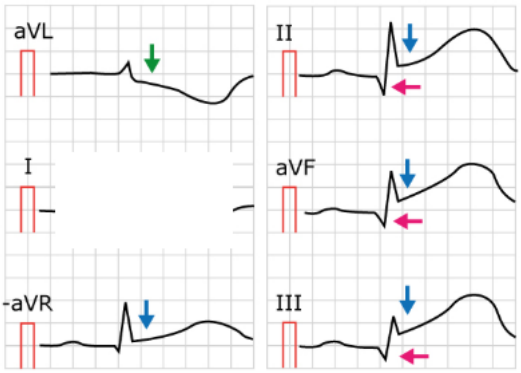
100 POINTS TOTAL - GOOD LUCK!

5. As seen in the figure on the right, the relative refractory period coincides with the T-wave of the EKG. This phase is described as a vulnerable phase in the cardiac cycle. (10 points)
    a. Why does the action potential in myocardium take much longer than an action potential on a nerve axon like the one seen in Problem 3?
    b. Why is the relative refractory period regarded as a vulnerable phase in the cardiac cycle?



The answer to 5b is on

https://learningcentral.health.unm.edu/learning/user/onlineaccess/CE/intro_baci_online/anat/phases.html



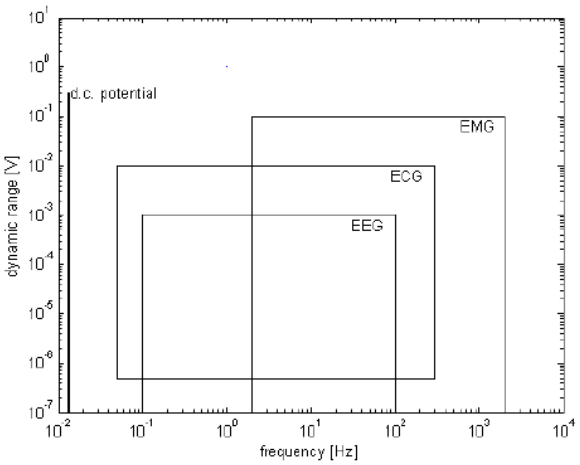
6. These EKG's on the left are from a 65-year-old diabetic patient within 3 hours of intense chest pain – he had transmural infarction, possibly as a result of extensive subendocardial ischemia. How do you think the Lead I EKG will look like? Interpret and explain. (10 points)

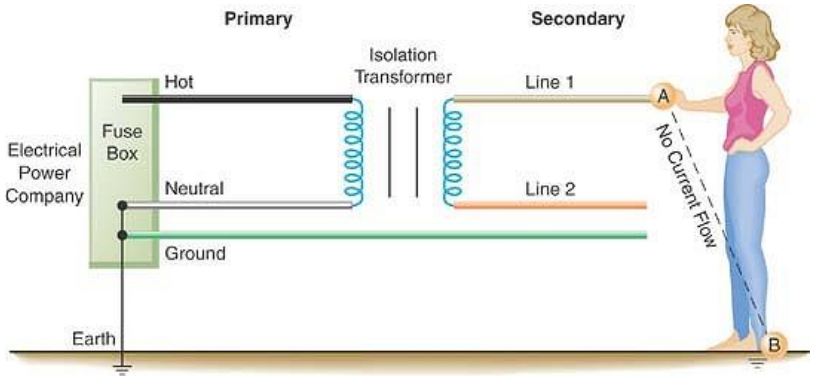
The answer to 6 is in on Slide 18 at https://www.slideshare.net/nfnajwa/acute-coronary-syndrome-acs

7. Explain within 3 sentences maximum the function of driven-right-leg circuit. (5 points)

8. What are the main interfering or modifying inputs to equipment in a hospital environment? How can you minimize them? (10 points)

9. In the figure to the right you see voltage and frequency ranges of some common biopotential signals. Analyze, compare and contrast sensitivity and specificity for those biopotential measurements. (10 points)





10. A safety feature of an isolated power system is illustrated on the left. An individual contacting one side of the isolated power system (point A or Line 1) and standing on the ground (point B) will not receive a shock. Will the woman receive a shock if she instead touches Line 2? Why? (10 points)