**PHM: Physiologic Energy Harvesting for Wearable Health Monitors**

**PROBLEM STATEMENT**

Wearable health monitors provide capabilities to manage chronic disease, monitor performance and stress levels of athletes and warfighters, and support wellness in remote or rural settings. A primary impediment, however, to wearable health monitoring is the need to recharge or replace power supply. This need reduces patient compliance and undermines the value of such devices. Moreover, continuous monitoring of key physical and environmental factors that influence health and well-being demands a low-powered sensor that provides sensitivity, specificity, and on-board regenerability. Its form factor must support performance and wearability with a pleasing aesthetic.

You are the Chief Technology Officer of a company that specializes in materials, devices and technology that are applicable to development of wearable health monitors. Your CEO believes that the company’s expertise in micro to nanoscale materials, processing, and devices could produce a health monitoring system that has (1) suitable power generation, form factor, and characteristics to harness available “free energy” from physiologically-available sources to provide point-of-use power; (2) low-power electronic component and circuit designed to minimize overall power consumption; and (3) fused sensors to provide physical and/or environmental data that support decision-making by patient and/or physician to manage disease, performance, or wellness. Validatable, continuous, and reliable service is key to its value. Your CEO’s opinion is that a plethora of energy harvesting devices based on vibrational technologies, e.g., cantilevers, are emerging and does not want to compete in this space. Therefore, such technologies are excluded from consideration in this proposal.

As CTO, you are to define an innovative product which harvests energy from the wearer to support a wearable health monitor in a safe, convenient, comfortable application. You should design, fabricate, and test a carefully selected group of elements in the product that reflects the particular expertise and capabilities of your organization. Any remaining elements should be specified in terms of usage parameters, but should utilize commercial off the shelf technology or be outsourced to appropriate vendor(s). You will deliver a complete proposal with your product plan for the company to your CEO by your Tuesday morning, January 17th deadline.

### **YOUR DELIVERABLE**

Your task is to write an internalproposal for your corporate officers describing your idea for research and product development. The proposal should include the following:

* Executive summary (one page)
* Risk assessment roadmap form (one page)
* Full proposal (15 pages maximum)
* Appendix A: List of references (no page limit)
* Appendix B: Ranked list of intellectual property documents examined (no page limit)

**Most Importantly** – The significance and novelty of your creative solution, one that moves the boundaries of knowledge outward, will be the primary assessment focus of your review panel. The list below is just a minimum list of issues you might consider. There may be many more. The point is that your proposal ***should contain the evidence*** needed to make an effective and compelling case to your CEO in order to ensure that she/he makes the right decision.

**At a minimum, be sure you address all of the following:**

**Current Science and Technologies** - What is already being done in this area by other researchers, companies and governmental institutions? Describe the current state-of-the-art for both the science and the implementation. Use diverse resources such as science literature, journals, conference proceedings, the internet, patents or other sources of existing public knowledge. ***Cite all references you use and use quotes for any word-for-word transfer to your report.***

**Your Design Approach –** What is the basis for your design approach to the problem? Why is your technology better than existing technologies? What technology attribute(s) makes it desirable relative to the alternatives? Address scientific *and* engineering aspects of these questions.

**Testing and Qualification** - Describe a set of tests you will use to demonstrate that your approach is effective and that your implementation of the solution will launch successfully.

**Cost Analysis** – Identify cost and market issues that will impact the pricing strategy of the solution you have proposed. Consider such things as: the major cost items that would impact the implementation; which elements of your implementation solution would be handled in-house versus externally-sourced; major risk elements that could drive up costs if the primary path item fails; costs of IP licensing needed, etc. Provide justification and/or reasoning behind your decisions. Estimate manufacturing cost for the total system as the technology reaches mature stage so the marketing team can determine potential for penetrating other markets. Avoid subcontracting manufacture or assembly of any proprietary component outside the company, because the CEO is concerned with potential IP leakage.

**Intellectual Property** – In Appendix B, list in rank order of importance ***all*** commercial, academic, and governmental IP sources that were consulted while formulating the answer, including reference data. For instance, include the patent number; title; inventor name; and assignee name for a patent. Discuss the 3 most significant IP documents affecting your approach to your solution in the 15-page document. Compare strengths and weaknesses of these approaches relative to your own. Recommend how these IP threats should be handled.

**Hint –** Clearly state your hypothesized solution. Identify its innovation(s) and advantages relative to state of the art. Describe both existing data, and work needed to support each aspect of the hypothetical solution. Consider theoretical, fabrication, and characterization aspects: for each, identify software/equipment and methods to use, parameters to vary, anticipated outcomes, and possible alternatives in the event of unsatisfactory results. Discuss material, process, device, and systems aspects of your solution. *Refine* your hypothesized solution as you accumulate information and prepare the manuscript. **Remember**: clearly distinguish what is known from what is hypothesized or not known. What is needed to distinguish the important things to know?

*Reference the 2017 PhD Candidacy Exam Guidelines document for general instructions.*