

**GLENN RESEARCH CENTER – Space Academy**  
**NASA “SOLAR” OPPORTUNITY – 2016**

**Mentor Name/Phone #:** Dr. Jerry Myers / 216.433.2864  
**Office/Division Name:** LT - Propulsion Division  
**Branch Name:** LTZ - Fluid Physics and Transport Processes Branch

**Project Title:** Modification of Hydrostatic Gradient in Lumped Parameter Model of the Human CNS and CVS Systems

**Type of Opportunity:**  X NASA Space Academy at Glenn

**Project Description:**

**1. Brief background & NASA mission/program support:**

**The NASA Human Research Program (HRP) is developing a method using numerical techniques to assess microgravity-induced fluid shifts.**

Astronauts undergo many physiological changes when exposed to the microgravity environment of space flight. Chief among these are changes in the cardiovascular, musculature and skeletal systems. Of particular concern to NASA, the fluid redistribution during microgravity potentially results in changes in visual acuity that may impair astronaut function. Although terrestrial methods exist to assess changes in cardiovascular (CVS) and central nervous system (CNS) fluid redistribution in tilt tests, such devices have proven to be unfeasible in space flight assessments. The NASA human research program seeks a method using numerical techniques to assess these fluid shifts and to assess the efficacy of countermeasures in preventing visual changes. A team of three to four students will work to incorporate one possible approach to developing this computational tool using lumped parameter modeling, modified to address short arm centrifugal gravitational gradients. .

**2. Objective of project:**

**Development and testing of lumped parameter models which incorporate cardiovascular data from short arm centrifugal gravitational gradient studies.**

This project involves modifying existing computational lumped parameter models to incorporate the effects of centrifugal “gravitation” gradients (i.e. artificial gravity). . The project will involve learning and applying techniques in modeling, solving sets of simultaneous non-linear equations, non-linear optimization and physiological regulation functions to specific gravitational scenarios. The challenge is to develop a feasible proof of concept process for assessing the efficacy of such countermeasures. The team will also assess various metrics for an appropriate central nervous system pressure metrics and relative assessment of changes in cerebral spinal fluid distribution due to space travel.

The students will learn a about engineering applications to address space flight medical risk factors, which will include an overview of medical, biomedical, mechanical, material and computer sciences and interfacing with experts in each field. Each team member will lead significant components of the project and will be responsible for integrating other team member effort. The intent is to reach a sufficient development level that the students will have a publication at an appropriate conference or journal publication by the end of their tenure.

**3. Specific student Team assignment:**

- a) Establish team - Students and mentors will meet to establish a plan and identify roles and responsibilities. The team will elect a leader who will be responsible for implementing the plan. A NASA manager will mentor the team leader.
- b) The team will derive the updated equations need to incorporate short centrifugal artificial gravity and review those with the mentor and other subject matter experts.

- c) The team will modify the existing CVS /CNS lumped parameter model hydrostatic components to accept the artificial gravity components
- d) The team will test the implementation using a set of linear/non-linear and steady/unsteady test set of test cases.
- e) The team will run 4 design reference mission simulation and present the results to the Fluid Physics and Transport Processing Branch at Glenn
- f) Report - Write a final report with intended publication as a NASA Technical Memorandum, conference paper or journal publication summarizing the results and recommendations.

**4. Expected outcomes** – include comments on

- (a) Research – R&D will address minimum requirements for establishing the updated lumped parameter models. .
- (b) Poster Presentation – and HRP Investigators’ Workshop (IWS) poster is expected in addition to the GRC poster
- (c) Final Report – completed final report will include full description of the process suitable for others to reproduce the work

**Desired Attributes:**

- \* Computer and/or Special Skills
- \* College/Academic Level at time of Internship or Fellowship:
  - X Senior or Rising Senior       X Master’s       X Doctoral
- \* Academic Disciplines/Majors – Engineering: Biomedical, Mechanical, Electrical, Computer science, or similar.

**Indicate program of choice for applicant:**

- NASA (Space) Academy

**Session(s)** (select):     X Summer 2016

**Alternate Mentor or Co-Mentor Name:** Dr. Beth Lewandowski    **Phone:** 3-8873      **Code:** LTZ

**ACRONYMS:**

SOLAR – Student On-Line Application for Recruiting Interns, Fellows and Scholars