**Course Title: Outline for “ENRE648L: Design and Analysis for Resiliency”**

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**3 Credits-Graduate**

Course Textbook and Materials:

1. Course Slides Prepared by the Instructor

References

-Nii O. Attoh-Okine, Resilience Engineering: Models and Analysis, 2016

-Ivo Häring - Risk Analysis and Management\_ Engineering Resilience-Springer Singapore (2015)

-Christopher P. Nemeth, Erik Hollnagel - Resilience Engineering in Practice\_ Becoming Resilient-Ashgate Pub Co (201

-Mathematical Modelling of System Resilience, Kanchan Das, Mangey Ram, River Publishers, 2019

Course Evaluation:

-Homework 30%

-No Midterm

-Final Exam 50%

-Class Term Paper 20%

 With extreme events become more common, preparation about the importance of resilience—or, broadly, the ability to prepare for and recover from abrupt changes and disasters is required more than ever. This course will teach the engineering students the technical approaches to measure resilience, analyze and design the systems, structure, and organization for resiliency. The course is meant for reliability, civil, mechanical, mechanical, industrial, and nuclear graduate students. The course does not have any pre-requisite. The background on optimization, applied probability, risk and reliability assessment will be helpful. The course will provide an overview on the necessary concepts and fundamentals first. The course outlines are as follows:

-Overview:

-Resiliency, Sustainability and Business Continuity

-Engineering Design.

 ✓Hardware, Software, Human Element

 ✓Socio-Technical System

 ✓Complex Systems

-Optimum Design

✓Optimum Design under Uncertainty

-Reliability, Risk, and Security Fundamentals

 ✓Resilience vs. Risk and Reliability

-Definition and Measures for Resilience.

-Qualitative, Quantitative; Probabilistic and Deterministic (Several Measures will be discussed in each class)

-Multi-attribute Nature of Resilience Measure

-System Perturbation Analysis

-Stability Analysis for Passive Structures and Active Systems

-Degradation Analysis

-System Resilience Engineering Techniques Overview:

 -Qualitative

-Semi-Quantitative and Quantitative

 ✓Model-Based

 ✓Ontology-Based

-Design for X; Design for Reliability, Risk and Resilience:

 -Risk Based Design

 -Risk Informed Design

 -Design for Risk-Based Reliability

 -Design for Resiliency

-Determination of Resilience Goals for Engineering Systems:

 -Reliability, Life and Confidence Level

 -Resilience, Performance upon Disturbance, Degradation, Restoration Time, and -

 Maintainability Management

 -Acceptance Criteria

-General Resiliency Optimization Platform:

 -Design Constraints

 -Techniques for Optimization for Reliability

 -linear, and non-linear Problems

-Genetic Algorithm (GA)

-Utilization of MATLAB Optimization

-Practical Examples of Industrial Projects; HVAC, Automotive, Petroleum Facilities, Gas Turbine, Centrifugal Pumps

-Resilience for Systems, InfraStructures and Organizations; Applications and Examples

-Resilience and Business Continuity in Supply Chains

Selected Topics:

-System Resiliency Growth and Improvement

 -Test, Evaluate, Improve and Test

 -Stress Testing

-Uncertainty Analysis for Resiliency

-Class Project for Students to do the Course Project