Course Title: Energy and Water Nexus **(Elective Course)**

Course Code: RE-824

Objectives: This course aims to equip the graduate students with the essential concept of water and energy nexus by encompassing technical, socio-economic, and environmental aspects. The course is expected to produce energy professionals having sound knowledge of water sustainable practices for energy sector of Pakistan. Moreover, students will also explore recent advancements in the field and become adept at designing and troubleshooting challenges as well as develop sound policies to combat growing energy-water crisis.

Specifically, the course will focus on the following objectives:

- To understand the concept of energy-water nexus and its need in the energy sector of Pakistan
- To address sustainable development goals (6 and 7) through sustainable energy-water nexus
- To appraise students with the recent advancement in technology and policies for sustainable energy generation and water use in the energy sector.
- To explore the role of energy resources in the water sector.

Learning Outcomes: On successful completion of the course, the student will be able to:

- Understand the concept of energy-water nexus, its relevance to SDGs and means to alleviating energy-water crisis in Pakistan.
- Gain in-depth knowledge of technical, socio-economic, and environmental challenges in energy-water nexus associated with energy sector of Pakistan.
- Identify energy-water interconnected issues and propose effective technologies and policies to strengthen the existing infrastructure for energy as well as the water sector.
- Recognize the role of energy in the water sector particularly during extraction, treatment, and distribution as well as in desalination process.

Course Contents:

Introduction to Energy and Water nexus: Energy and Water interaction, Energy and Water role in SDGs, Competition and conflicts between energy and water systems

Impact of climate change on water and energy nexus: Impact on water resources and energy production and demand.

Water for Energy I: Conventional Energy – Water Nexus: Water for coal-handling and processing (mining, cleaning, liquification…), Water for crude oil, natural gas production and processing, Potential impacts on water quality and availability, Water for cooling technologies in Thermal Power Plants TPPs, Water for carbon capture and storage (CCS) technology, Emerging technologies/sustainable practices to reduce water use in coal, oil, and gas industry.

Water for Energy II: Nuclear Power Plant (NPP): Water use and consumption in major phases of NPP (during construction, commissioning, operation, shutdown state and decommissioning), Available technologies for cooling systems, Water pollution from NPP, Water treatment pathways for NPP, Strategies for reducing water use and consumption in NPP.

Water for Energy III: Renewable Energy-Water Nexus: Current water use, technologies, and associate issues in various RE systems such as Solar, Wind power, Biofuels, Hydropower, Geo-hydrothermal, and Hydrogen. Sustainable water practices for RE systems.

Energy for water I: Water Extraction, Treatment and Distribution: Energy for water extraction, pumping, treatment, and supply, Renewable energy powered water sector

Energy for water II: Desalination: Desalination and energy Consumption, Desalination Technologies

Case Studies on Energy and Water Sustainability

Recommended Books:

- Water and Energy: Threats and Opportunities Gustaf Olsson, IWA 2015
- The Water-Energy Nexus: Challenges and Opportunities US. Department of Energy 2014 DoE
- Efficient Water Management in Water Cooled Reactors IAEA Nuclear Energy Series 2012

- Water for Energy: Addressing the Nexus between Electricity Generation and Water Resources
- Glen Andersen, Megan Cleveland, Daniel Shea ACS