Nuclear Energy Engineering

1.2 **Course Number**: CH305

1.3 **Contact Hours**: 3-0-0 Credits: 9

1.4 **Semester -Offered**: 3rd Year- even

1.5 **Syllabus Committee Member**: Dr Vivek Kumar, Dr Milan Kumar

2. Objective: The objective of course is to make student familiar with the fundamentals of nuclear power generation starting from the atomic structure and nuclear physics. The student will also be learn the design of different reactors.

3. Course Content

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topics	Lectures
1	Atomic & nuclear physics	Overview of atomic structure, equivalence of mass and energy, stability of nucleus, radioactive decay, binding energy, different nuclear reactions, natural radioactivity. Interaction of radiation with matter: Interactions of charged particle, α- and β-particle, photons, radiation detectors	4
2	Neutron physics	Nuclear interactions, concept of cross-section, cross-section measurement, neutron interactions, neutron scattering, fission chain reaction	4
3	Neutron diffusion and scattering	One-speed diffusion equation and its solution, neutron diffusion in multiplying media, diffusion in elementary reactors, multi-group neutron diffusion theory, moderation and scattering, diffusion of thermal neutrons	6
4	Time-dependent neutron transport	Delayed neutrons, diffusion in transient reactors, reactor kinetics	4
5	Nuclear fuel	Properties of fuel and cladding, nuclear fuel cycle, isotope separation, fuel reprocessing, radioactive waste disposal	4
6	Nuclear reactor control	Control rod and chemical shim, effect of temperature on reactivity, fission product poisoning	4

7	Thermal hydraulics of reactors	General thermodynamic consideration, thermal hydraulic analyses of simple block and cylindrical reactors.	4
8	Thermal reactors	Pressurized and boiling water reactor, heavy water reactor, Gen-III+ and Gen-IV designs	2
9	Breeder reactors	Concept of breeding and breeding potential, fast breeder reactor.	2
10	Principle of nuclear fusion Radiation protection	Biological effects of radiation, calculation of radiation effects, computation of exposure and dose, philosophy of reactor safety & containment.	6
		Total	**40**

4. **Readings**

4.1 Textbooks:

1. R Lamarsh & AJ Baratta, Introduction to Nuclear Engineering, 3rd Eds., Pearson, 2001
2. RL Murray & KE Holbert, Nuclear Energy: An Introduction to the Concepts, Systems and Application of Nuclear Processes, 7th Eds., Elsevier, 2015.

4.2 Reference Books:

1. MM El-Wakil, Power Plant Technology, McGraw-Hill Education, 2017.
2. DG Cacuci (Eds.), Handbook of Nuclear Engineering, Vol I: Nuclear Engineering Fundamentals, Springer, 2010.
3. CE Brennen, Introduction to Nuclear Power Generation, Dankat Publishing Company, 2005.
4. Tsoulfanidis, Nuclear Energy, Springer, 2018.
5. NE Todreas & MS Kazimi, Nuclear Systems I & II, Taylor & Francis, 1993.
6. RA Knief, Nuclear Engineering: Theory and Technology of Commercial Nuclear Power, 2nd Eds., American Nuclear Society, 2008.
7. E Lewis, Fundamentals of Nuclear Reactor Physics, Academic Press, 2008.

5. **Outcome of the course:** At the end of the course student will have the ability to apply knowledge course to the analysis of nuclear and other systems. The student will also have ability to nuclear engineering problems.