## Course Contents

1. Give details of the course, on the following lines:

   a. Course Code ESE-824

   b. Title Nuclear Energy Engineering

   c. Credit Hours 3

   d. Objectives

   The objectives of this Nuclear Energy Engineering course are:

   (1) To discuss the basic concept of nuclear energy

   (2) To describe the interaction of radiation with matter

   (3) To explain the construction and working of nuclear reactors and be able to differentiate types of reactor

   (4) To provide the essential knowledge of nuclear reactor components and their characteristics

   (5) To enlighten the essential concept of nuclear reactor theory and to develop fundamental calculation skills

   (6) To describe the heat removal generated from nuclear reactor to produce steam and explain the phenomenon's involved during this process.

   (7) To discuss the safe operation of nuclear reactor, excessive risk to staff and environment and prevent incident

   (8) To provide knowledge and explain the practical aspect of radiation protection and radiation shielding

   e. Outcomes

   (1) This course demonstrates the students to know the aspects of nuclear reactor physics.

   (2) The students will be able to differentiate between different types of reactors, next generation nuclear power plant, and fuel cycles.

   (3) The students will be familiar about the nuclear reactor components and working.

(4) The course will provide in-depth knowledge of nuclear reactor theory and understand the phenomenon of heat transfer from reactor core to produce steam.

(5) The topic of radiation protection and reactor safety reveals their importance in commercial nuclear power plants.

f. Contents with suggested contact hours

| No. | Topics | Book | Contact Hours |
|---|---|---|---|
| 1. | **Introduction to Nuclear Energy**<br>• Role and importance of nuclear energy<br>• Nuclear Power Planning And Economics<br>• Particle Wavelength<br>• Excited states and radiation<br>• Nuclear stability and radioactive decay<br>• Nuclear reaction<br>• Binding energy<br>• Nuclear models | LB | 4 |
| 2. | **Interaction of radiation with matter**<br>(a) Neutron Interaction<br>(b) Cross-sections<br>(c) Neutron Attenuation<br>(d) Neutron Flux<br>(e) Neutron Cross-Section data<br>(f) Energy loss in scattering collision<br>(g) Fission<br>(h) γ-ray interaction with matter | LB | 4 |
| 3. | **Nuclear reactor**<br>(a) Fission chain reaction | LB | 7 |

| | | | |
|---|---|---|---|
| | (b) Nuclear reactor fuel<br>(c) Categories of Nuclear Power Plant<br>(d) PWR<br>(e) BWR<br>(f) CANDU<br>(g) Small Modular Reactor<br>(h) Nuclear cycles<br>(i) Isotope separation<br>(j) Fuel reprocessing<br>(k) Next generation power plant | | |
| 4. | **Nuclear Reactor Systems and components**<br>(a) Steam generator<br>(b) Pressurizer<br>(c) Steam supply system<br>(d) Emergency core cooling system<br>(e) Filtered vented containment system<br>(f) Passive containment cooling system<br>(g) Containment Spray System<br>(h) Turbine Building<br>(i) Control room | LB | 7 |
| 5. | **Nuclear reactor theory**<br>(a) Neutron Flux<br>(b) Fick's Law<br>(c) Equation of continuity<br>(d) Diffusion equation<br>(e) Boundary conditions<br>(f) Diffusion length<br>(g) One-group reactor equation<br>(h) Slab reactor and other reactor shapes<br>(i) Thermal reactors<br>(j) Reflected reactors | LB | 7 |

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| 6. | **Heat Removal from reactor**<br>(a) Thermodynamics<br>(b) Heat generation in reactors<br>(c) Heat flow by conduction<br>(d) Heat transfer to coolants<br>(e) Boiling Heat transfer | LB | 7 |
| 7. | **Nuclear reactor safety**<br>(a) Reliability<br>(b) Introduction to risk<br>(c) Safety<br>(d) PSA 1, 2, 3<br>(e) LPSA<br>(f) Risk Monitoring | LB/GP | 4 |
| 8. | **Radiation protection and shielding**<br>(a) Definition and units of radiation<br>(b) Biological effects of radiation<br>(c) Calculation of radiation protection<br>(d) Principles of reactor shielding<br>(e) Gamma-ray Shielding | LB | 5 |
| Total | | | 45 |

g. Details of lab work,workshops practice (if applicable).

No lab is required.

h. Recommended Reading (including Textbooks and Reference books).

| S. No. | Title | Author(s) | Assigned Code | Remarks |
|---|---|---|---|---|
| 1. | Introduction to Nuclear Engineering, 3rd Ed., Prentice Hall, 2001 | J. R. Lamarshand A. J. Baratta | LB | Text Book |

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|---|---|---|---|---|
| 2. | Nuclear reactor analysis, John Wiley & Sons, New York, 1976. | J. J. Duderstadt and L. J. Hamilton | DL | Reference |
| 3. | Fundamentals of Nuclear Reactor Physics | E. E. Lewis | EE | Reference |
| 4. | Nuclear Energy: An introduction to the concepts, systems, and applications of nuclear processes, 6$^{th}$Edition, Elsevier Inc., 2009 | R. L. Murray | RM | Reference |
| 5. | Handbook of Nuclear Engineering, Springer 2010 | D. G. Cacuci | GC | Reference |
| 6. | Nuclear Engineering Theory and Technology of Commercial Nuclear Power 2008 | R. A. Knief | RK | Reference |
| 7. | Nuclear Safety | Gianni Petrangeli | GP | Reference |