Academic Course Description
BHARATH UNIVERSITY
Faculty of Engineering and Technology
Department of Mechanical Engineering
BGE009- Nuclear Engineering
Eight Semester, 2015-16 (Even Semester)

Course (catalog) description

To gain some fundamental knowledge about nuclear physics, nuclear reactor, nuclear fuels, reactors and safe disposal of nuclear wastes.

Compulsory/Elective course : Elective for Mechanical students

Credit & contact hours : 3 & 45

Course Coordinator : Dr.Shanmuganandh

Instructors : Karthikeyan S

Name of the instructor	Class handling	Office location	Office phone	Email (domain:@ bharathuniv.ac.in	Consultation
Karthikeyan S	VIII Sem	JR108		karthikeyans.mech@ bharathuniv.ac.in	Wednesday 12.30 to 01.30

Relationship to other courses:

Pre –requisites **:** Thermal Engineering

Assumed knowledge **:** Nuclear physics, Nuclear reactor, Nuclear fuels, reactors and safe disposal of Nuclear wastes.

Following courses **:** Nil

Syllabus Contents

UNIT I : Atomic structure and Nuclear reactors & neutrons and interaction 8 Hours
Atomic structure, Nuclear Equation- Energy from nuclear reactions –fusion and fission, nuclear technology, conversion and breeding –Radio activity, effect of radiation. Thermal neutrons, buckling factor, nuclear cross-section, Neutron flux, Volumetric Thermal Source strength-Fission, crosssection in reactors.

UNIT II : NEUTRON FLUX DISTRIBUTION 10 Hours
Neutron life cycle, neutron conservation equation, diffusion equations, reflectors and their effect, Reactivity and reactivity period-Multiplication factor. Void and Void factor, Flow and non-flow system, simple problems-Boiling and non boiling heights, Friction drop in a two-phase channel.

UNIT III : REACTOR HEAT GENERATION **8 Hours**

Heat conduction in reactor elements, heat flow of solid planes.Types of fuel elements. Heat flow out of spherical fuel elements, Effect of cladding and coolant absorption of core radiation, Heat removal in slab subjected to radiation, problems, Thermal shields, secondary Radiation.

UNIT IV : CORE THERMAL DESIGN **10 Hours**

General consideration ,Arial Temperature ,Distribution of fuel element and coolant, Maximum temperature in fuel elements, Problems, coolant channel orificing, hotspot factors, Core thermal design ,selection of fuel materials, cladding, coolant, moderator, control rods- structural parts- safety considerations and site solution –Disposal of Radioactive waste.

UNIT V : REACTORS **9 Hours**

Boiling water reactor- B.W.R modified Rankine cycle, Heavy water reactors, as cooled Reactor, liquid metal cooled reactor, Compatibility of liquid metal coolant. Site layout, Shielding and containment decontamination, Hazard evaluation and likening.

Total : 45 Hours

TEXTBOOKS:

M.M.E.I Wakil, Nuclear Power Engineering, International Textbook Company.

REFERENCES:

1. R.L.Murray, Introduction to Nuclear Engineering, Prentice hall.
2. M.M.E.I Wakil, Nuclear Power Engineering ,International Textbook company
3. Gasstone, Nuclear Reactor Engineering ,CBS 1998
4. M.M.E.I Wakil, Nuclear energy conservation, International Textbook Company.
5. www.springer.com/us/book/9783642488788

Computer usage:

Professional component

General	-	0%
Basic Sciences	-	0%
Engineering sciences & Technical arts	-	0%
Professional subject	-	100 %

Broad area: Conventional Energy

Test Schedule

S. No.	Test	Tentative Date	Portions	Duration
1	Cycle Test-1		Session 1 to 14	2 Periods
2	Cycle Test-2		Session 15 to 28	2 Periods
3	Model Test		Session 1 to 45	3 Hrs
4	University Examination		All sessions / Units	3 Hrs.

Mapping of Instructional Objectives with Program Outcome

Learning about alternate energy and its potential for the future generation.	Correlates to program outcome		
	H	**M**	**L**
1. Will gain some fundamental knowledge about nuclear physics.		A	
2. Will acquire knowledge about nuclear reactor.	E,l	H	
3. Will understand about nuclear fuels and will become capable of handling nuclear waste.	L	A	
4. Will understand about core thermal design	E,l		J
5. Will understand about Disposal of Radioactive waste	C,e,l	A	
6. To learn about boiling water reactor			

H: high correlation, M: medium correlation, L: low correlation

Draft Lecture Schedule

Session	**Topics**	**Problem Solving (Yes/No)**	**Text/Chapter**
UNIT I : ATOMIC STRUCTURE, NUCLEAR REACTORS, NEUTRONS AND INTERACTION			
1	Introduction, Nuclear energy	No	[T1],[R1]
2	Fission, Fusion & working of reactor	No	
3	Radio activity, effect of radiation	No	
4	Thermal neutrons, buckling factor	No	
5	Nuclear cross-section, Neutron flux	No	
6	Volumetric Thermal Source strength	No	
7	Fission, cross-section in reactors.	No	
8	Recap, nuclear energy working and parameters	No	
UNIT II : NEUTRON FLUX DISTRIBUTION			
10	Neutron life cycle	No	[T1] [R1]
11	Neutron conservation equation	No	
12	Diffusion equations, reflectors and their effect	No	
13	Reactivity and reactivity period	No	
14	Multiplication factor	No	
15	Void and Void factor	No	
16	Flow and non-flow system	No	
17	Boiling and non boiling heights	Yes	
18	Friction drop in a two-phase channel	Yes	
19	Summary of neutron flux distribution		

UNIT III : REACTOR HEAT GENERATION			
19	Heat conduction in reactor elements	No	[T1], [R3]
20	Heat flow of solid planes	No	
21	Types of fuel elements	No	
22	Heat flow out of spherical fuel elements	No	
23	Effect of cladding and coolant absorption of core radiation	No	
24	Heat removal in slab subjected to radiation	No	
25	Thermal shields, secondary Radiation	No	
26	Problems on heat generation	Yes	
UNIT IV : CORE THERMAL DESIGN			
28	General consideration ,Arial Temperature	No	[T1],[R3]
29	Distribution of fuel element and coolant	No	
30	Maximum temperature in fuel elements	No	
31	Problems, coolant channel orificing	Yes	
32	Hotspot factors	No	
33	Core thermal design	No	
34	Selection of fuel materials, cladding, coolant, moderator, control rods-	No	
35	Structural parts- safety considerations and site solution	No	
36	Disposal of Radioactive waste	No	
37	Quick recap	No	
UNIT V : REACTORS			
37	Reactor parts, Types and working	No	[T1],[R5]
38	Boiling water reactor	No	
39	B.W.R modified Rankine cycle	No	
40	Heavy water reactors, as cooled Reactor	No	
41	Comparisons of reactors studied	No	
42	Compatibility of liquid metal coolant	No	
43	Site layout, Shielding and containment decontamination	No	
44	Hazard evaluation and likening	No	
45	Summary of Nuclear power plant functioning	No	

Teaching Strategies

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

Evaluation Strategies

Cycle Test – I	-	5%
Cycle Test – II	-	5%
Model Test	-	10%
Assignment / Seminar / Online Test / Quiz	-	5%
Attendance	-	5%
Final exam	-	70%

Prepared by Dr.Shanmuganandh

Addendum

ABET Outcomes expected of graduates of B.Tech / MECH / program by the time that they graduate:

a) The ability to apply knowledge of mathematics, science, and engineering fundamentals.
b) The ability to identify, formulate and solve engineering problems.
c) The ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d) The ability to design and conduct experiments, as well as to analyze and interpret data
e) The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
f) The ability to apply reasoning informed by the knowledge of contemporary issues.
g) The ability to broaden the education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
h) The ability to understand professional and ethical responsibility and apply them in engineering practices.
i) The ability to function on multidisciplinary teams.
j) The ability to communicate effectively with the engineering community and with society at large.
k) The ability in understanding of the engineering and management principles and apply them in project and finance management as a leader and a member in a team.
l) The ability to recognize the need for, and an ability to engage in life-long learning.

Program Educational Objectives

PEO1: PREPARATION:

Mechanical Engineering graduatesare enthusiastic to provide strong foundation in mathematical, scientific and engineering fundamentals necessary to analyze, formulate and solve engineering problems in the field of Mechanical Engineering.

PEO2: CORE COMPETENCE:

Mechanical Engineering graduates have competence to enhance the skills and experience in defining problems in the field of Mechanical Engineering and Technology design and implement, analyzing the experimental evaluations, and finally making appropriate decisions.

PEO3: PROFESSIONALISM:

Mechanical Engineering graduates made competence to enhance their skills and embrace new thrust areas through self-directed professional development and post-graduate training or education.

PEO4: PROFICIENCY:
Mechanical Engineering graduates became skilled to afford training for developing soft skills such as proficiency in many languages, technical communication, verbal, logical, analytical, comprehension, team building, inter personal relationship, group discussion and leadership skill to become a better professional.

PEO5: ETHICS:
Mechanical Engineering graduates are morally merged to apply the ethical and social aspects of modern Engineering and Technology innovations to the design, development, and usage of new products, machines, gadgets, devices, etc.

Course Teacher	Signature
Karthikeyan S	

Course Coordinator **HOD/MECH**
Dr.Shanmuganandh