COURSE STRUCTURE FOR M.TECH (Nuclear Engineering)
SEMESTER II
w.e.f. 2013-2014

Sr. No	Course Code	Course Name	Teaching Scheme					Exam Scheme					
			L	T	P	C	Hrs/wk	Theory			Practical		Total
								MS	ES	IA	LW	LE/Viva	Marks
1.	NE505	Nuclear Plant Operation, Dynamics and control	3	1	0	7	4	30	60	10	--	--	100
2.	NE506T	Radiation Measurement and Radiation Protection	3	0	0	6	2	30	60	10	--	--	100
3.	NE506P	Radiation Measurement Lab	–	–	4	2	4				40	60	100
4.	NE507	Nuclear Power Plant Engineering	3	1	0	7	4	30	60	10	--	--	100
5.	NE508	Nuclear Safety	2	0	0	4	2	30	60	10	--	--	100
6.	NE509	Nuclear Fuel Cycle	3	0	0	6	3	30	60	10	--	--	100
7.	*NE510	Multivariable Control Theory	3	0	0	6	3	--	--	--			
8.	*NE511	Reliability in Nuclear Power Plants	3	0	0	6	3						
9.	*NE512	Computational Neutron Transport and radiation shielding	3	0	0	6	3	30	60	10			100
10.		Introduction to Research Methodology	2	0	0		2						
		Total	19			36	24						

MS = Mid Semester, ES = End Semester; IA = Internal assessment (like quiz, assignments etc)

LW= Laboratory Exam LE = Laboratory Exam

Elective (Select one)

***EN510 Multivariable Control Theory, *EN211 Reliability in Nuclear Power Plant, *NE212 Computational Neutron Transport and Radiation Shielding**

NE 505 Nuclear Plant Operation, Dynamics and Control										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
3	0	0	6	3	40	60	--	--	--	100

Measurements Concepts and Definitions , Pressure, Level, flow and Temperature Measurement, Control Theory and The Laplace Transform Mathematical Modeling and Dynamic behavior, Transfer Functions and Closed Loop Control Systems, Block Diagrams Transient Response Analysis, Frequency Response & Stability Analysis , Controller and Control Actions, Control Physics and Reactor Kinetics, Reactor Transfer Functions, PPP Control System, Functional Requirements, Operational Control Requirements, Refresher on Basic Control Physics, Reactor Kinetics; Open Loop Response,Transient and Steady State PerformanceBasic Concept of Stability, Stability Analysis, Controller Design Issues, PHWR Reactor Transfer Function, Reactor Transfer Function; Temperature & Poisoning Feedbacks, Case Illustrations on Practical Plant Control Systems, Case Illustrations on Practical Control System Design Studies

References/ Books:

1. Young, Peter, " Recursive Estimation and Time Series Analysis" Springer Verlag, Berlin
2. Soderstrom and Stoica, "System Identification", Prentice Hall
3. L. Ljung, "System Identification: Theory and Practice for Users", Prentice Hall

NE506T Radiation Measurement and Radiation Protection										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
2	0	0	4	2	40	60	--	--	--	100

Sources of Nuclear Radiation, Basic Principles of Radiation Interactions and Transport, Radiation Detection Instruments, Counting Statistics, Determination of Exposure and Limits for Internal and External Emitters, Radiation Shielding, Build-up Factors, Dose Calculation, Biological Effects of Radiation and Radiation Protection Standards

References/ Books:

1. J. E. Turner, "Atoms, Radiation, and Radiation Protection", Wiley
2. Jacob Shapiro, "Radiation Protection: A guide for scientists and Physicians", Harvard University Press
3. J. R. Lamarsh and A. J. Baratta, "Introduction to Nuclear Engineering" Prentice Hall
4. S. S. Kapoor & V. S. Ramamurthy, "Nuclear Radiation Detectors", New Age International
5. G. F. Knoll, "Radiation Detection and Measurement", John Wiley and Sons, New York

NE507 Nuclear Power Plant Engineering										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
3	1	0	7	4	40	60	25	--	--	125

Design basis for components, design and operating loads for mechanical components, Reactor core materials, Nuclear reactor design, Steam and gas power cycles, Reactor process systems and equipment, Reactor auxiliary systems, Reactor protection systems, Reactor control systems, Reactivity mechanisms, Types of nuclear fuel and fuel management systems, Fatigue and creep considerations in design of mechanical components, Criterion for the selection of materials of mechanical equipment

Design of mechanical equipment in nuclear power plant

Reactor pressure vessel ,Steam Generator, Pressuriser, Reactor coolant pump, Control rod drive mechanisms , Shielding , Codes, standards and specifications, Life assessment and life extension, Introduction to ANSYS software as a tool for design/Analysis of mechanical equipment

References/ Books:

1. Manjula B Waldron and Kenneth j. Waldron, "Mechanical Design: Theory methodology", Springer Verlag, New York
2. John F. Harvey, "Theory and Design of Modern Pressure vessels", Van Nostrand Reinhold Company New York
3. Kenneth D. Kok (ed.) "Nuclear Engineering Hand book"

NE508 Nuclear Safety

Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
2	0	0	4	2	40	60	--	--	--	100

Technical aspects of plant safety :

Accident initiating mechanisms ,Analysis of loss of flow accidents , Loss of coolant analysis, Containment loading , Active and passive engineered safety systems. Radioactive materials dispersion in the environment, Calculation of expected dose following an accident

Emergency planning :

Safety philosophy:

References/ Books:

1. **Ralph Fullwood and Robert Hall, "Probabilistic Risk Assessment in the Nuclear Power Industry", Pergamon Press**
2. **E. E. Lewis, "Nuclear Power Reactor Safety", Wiley Inter-science**

NE509 Nuclear Fuel Cycle											
Teaching Scheme					Examination Scheme						
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
3	0	0	6	3	40	60	--	--	--	100

Introduction, Nuclear fuels, Mining and processing of Uranium, Uranium technology, Zirconium process, Fabrication of fuel assemblies, PWR fuel, mixed-oxide fuel, Irradiated fuel, Reprocessing, Incore fuel management, Radioactivity, Contamination, Waste management, Enrichment of uranium, Thorium cycle, Fast reactor fuel cycle and fuel fabrication, Environmental impact and safety, Management of radioactive and hazardous waste generated by all segments of nuclear fuel cycle and users of radioisotopes

References/ Books:

1. P. D. Wilson, "The nuclear fuel cycle: from ore to wastes", Oxford University Press,
2. H.W.Graves,"Nuclear Fuel Management", John Wiley,

*NE510 Multivariable Control Systems										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
3		0	6	4	40	60		--	--	100

Examples of Multivariable Control Systems, State Space, Polynomial and Stable Fraction Models, Controllability, Observability and Computations involved in their analysis, Realization theory of Multivariable Systems and Algorithms, Stability by Lyapunov's method, Solution of Lyapunov equations, Pole Placement, Observer design and stabilization theory, Spectral factorizations of systems, Solution of the Ricatti equation, Balanced Realizations and their computations

References/ Books:

1. **C.T.Chen, "Linear system theory and design", Oxford**
2. **John Bay, "Fundamentals of linear state space systems", McGraw Hill**
3. **Wilson Rugh, "Linear system theory", Prentice Hall,**

*Elective Course

*NE511 Reliability in Nuclear Power Plants											
Teaching Scheme					**Examination Scheme**						
L	**T**	**P**	**C**	**Hrs/Week**	**Theory**		**Tutorial**	**Term Work**	**Practical /Viva**	**Total Marks**
					MS (2.0Hrs)	**ES (3.0Hrs)**				
3	**0**	**0**	**6**	**3**	**40**	**60**	**--**	**--**	**--**	**100**

Introduction of Reliability concepts, Current techniques for determining the reliability of nuclear plant systems, The risk associated with the operation of these advanced technology systems, Elements of Probability Theory, Elements of Statistical Theory, Statistical Failure Models,System Reliability, Reliability Improvement, Maintanability and Availability, Fault Tree Analysis
Failure Mode Effect Analysis

References/ Books:

1. **Ralph R. Fullwood, "Probabilistic Safety assessment in the Chemical and Nuclear Industry", Butterworth Heinemann**
2. **Gianni Petrangeli, "Nuclear Safety", Butterworth-Heinemann**
3. **Alessandro Birolini, "Reliability Engineering: Theory and Practice", Springer**

*Elective course

*NE512 Computational Neutron Transport and Radiation Shielding										
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory		Tutorial	Term Work	Practical /Viva	Total Marks
					MS (2.0Hrs)	ES (3.0Hrs)				
3	1	0	7	4	40	60	25	--	--	125

The linear Boltzmann equation :

Derivation of the linear Boltzmann equation, Underlying assumptions, Derivation of the integral transport equation, Solution of the one-speed transport equation, Case's method of singular eigen-functions

Multi-group discrete ordinates (S-N) method:

Boundary conditions, Conservation form in curved geometry, One and multi-dimensional problems, Inner and outer Iterations, Spatial discretization, angular discretization, Difference relations, quadrature coefficients and weights, Attenuation relations, Principal of directional evaluation, K-eff and source problems, Convergence acceleration techniques, The adjoint problem, Application to shielding problems

Various other methods:

Introduction to the P-N method, P-1 approximation and diffusion equation, Mark and Marchek boundary conditions, Introduction to the Collision probability method, Introduction to the Monte Carlo method, Application to shielding problems

Textbooks and References:

1. **George I. Bell and Samuel Glasstone, "Nuclear Reactor Theory", Van Nostrand Reinhold Company**
2. **E. E. Lewis and W. F. Miller Jr., "Computational Methods of Neutron Transport", American Nuclear Society**

* Elective course