UNIVERSITY OF NEW BRUNSWICK

DEPARTMENT OF CHEMICAL ENGINEERING

UNENE COURSE

UN 702

POWER PLANT THERMODYNAMICS

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POWER PLANT THERMODYNAMICS

COURSE OUTLINE

MODULE 1: *STEAM POWER CYCLES*

Thermodyanmic Processes
Thermodynamic Laws
Superheating and Reheating
Regenerative Feedwater Heating
Moisture Separation and Reheating
Turbine Expansion Lines

MODULE 2: *EXERGY AND HEAT TRANSFER*

Available Energy Transfer
Exergy Flow Diagrams
Thermo-economic Analysis
Heat Conduction and Convection
Boiling and Condensing
Two Phase Flow

MODULE 3: *NUCLEAR HEAT REMOVAL*

Reactor Heat Generation
Heat Transfer in Boilers and Condensers
Boiler Influence on Heat Transport System
Boiler Swelling and Shrinking
Boiler Level Control
Boiler Operation

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GRADING GUIDELINES

EVALUATION

FIST ASSIGNMENT	20%	
SECOND ASSIGNMENT	20%	
FINAL EXAMINATION	60%	(3 hours)

The final examination is closed book with selected notes and tables supplied.

GRADING

A+	above 90%
A	above 85%
A-	above 80%
B+	above 75%
B	above 70%
B-	above 65%
C+	above 60%
C	above 55%
C-	above 50%

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SCHEDULE

MODULE 1: STEAM POWER CYCLES

31 March 2007 Thermodynamic Theory
1 April 2007 Steam Cycle Theory

MODULE 2: EXERGY AND HEAT TRANSFER

14 April 2007 Exergy Analysis
15 April 2007 Thermal Fluid Theory

MODULE 3: NUCLEAR HEAT REMOVAL

28 April 2007 Reactor Heat Removal
29 April 2007 Reactor Steam Generation

FINAL EXAMINATION

11 May 2007 Whole Course

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ASSIGNED WORK

There will be two blocks of assigned work following and based on Module 1 and Module 2. The assigned work will be to obtain real plant data from one of the plants for a particular component, to develop a new question (similar to a full 15 mark questions in the question bank) and to provide a complete solution to the question.

MODULE 1 ASSIGNMENT: EXERGY ANALYSIS

For a specified heat exchange component in the steam cycle (boiler, reheater, condenser, feedheater, etc.) list all specified data, determine flow rates, calculate thermal efficiency, determine effectiveness of available energy transfer and comment on the results. Complete solutions and explanations of method and assumptions made must be submitted. Due 15 April 2007.

MODULE 2 ASSIGNMENT: HEAT TRANSFER

For a specified heat exchanger component in the steam cycle (boiler, reheater, condenser, feedheater, etc.) list all specified data, determine flow rates, calculate heat transfer coefficients and determine the rate of heat exchange. Compare the calculated rate of heat exchange with the specified value and comment on and explain any discrepancies. Complete solutions and explanations of method and assumptions made must be submitted. Due 27 April 2007.

Note: All work must be entirely independent and students from the same plant may not use the same component in that plant for their analysis.

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FINAL EXAMINATION

The final examination will be based on the Question Bank, that is, the same or very similar questions will be set. The Question Bank sets the standard for the course with regard to breadth and depth of material. Since however the Question Bank is an evolving document, new questions are possible particularly with regard to descriptive material from the Course Notes.

The final examination will be structured as follows:

Descriptive Section:	Three Questions of 15 marks each. Do any Two Questions (30 marks)
Calculative Section:	Four Questions of 15 marks each. Do any Three Questions (45 marks)

The total is thus Five Questions (75 marks) and the nominal time allowed is three hours though some extra time is usually permitted.

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QUESTION BANK

The Questions Bank contains problems similar to those that will be set in the final examination. New problems are created each year and some modified for examination purposes. Past examination questions are identified by a date and the mark value for these questions is given. Generally a full hand written page of a descriptive answer or a full page of detailed calculations is 5 marks. Hence three pages for 15 marks. This is a senior course and students are expected to have developed the required direction and motivation to be able to work on their own. Students are expected to work from the Question Bank on an ongoing basis. Where possible answers will be given to the problems and students are required to work on their own, using the printed notes as reference, towards these answers.

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COURSE PREREQUISITES

The course is based on the practical applications (with respect to nuclear power plants) of the following engineering disciplines:

- **Thermodynamics**
- **Heat Transfer**
- **Fluid Mechanics**

Students therefore must have a good knowledge of thermodynamic principles (heat and energy, steam tables, T-s and h-s diagrams) a basic knowledge of fluid mechanics (energy and momentum) and some understanding of heat transfer (conduction and convection)

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COURSE NOTES

The course notes consist of selected Articles from the UNESCO sponsored Encyclopedia of Life Support Systems (EOLSS). See attached for scope of Theme 3.10 Thermal Power Plants. These articles were based on the instructor's course material for parts of two senior level courses at UNB so are uniquely relevant for this course. These articles are copyright protected and are for students' own use only.

MODULE 1 STEAM POWER CYCLES

Article 3.10.1.4 Thermodynamic Theory
Article 3.10.1.5 Power Plant Steam Cycle Theory

MODULE 2 EXERGY AND HEAT TRANSFER

Article 3.10.1.6 Exergy Analysis
Article 3.10.1.3 Thermal Fluid Theory

MODULE 3 NUCLEAR HEAT REMOVAL

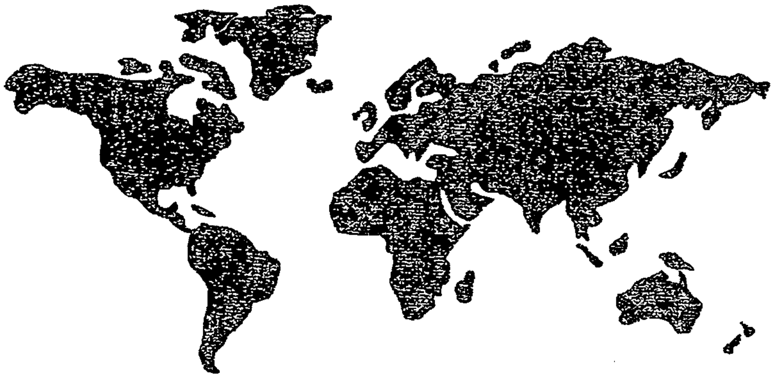
Article 3.10.2.9 Nuclear Reactor Heat Removal
Article 3.10.2.10 Nuclear Reactor Steam Generation

For students lacking in background in Thermodynamics the following class notes from an entry level course at UNB are included in Module 1.

Section 2 Steady Flow Processes
Section 4 Steam Tables and Charts
Section 7 Steam Power Cycles

EOLSS

ENCYCLOPEDIA OF LIFE SUPPORT SYSTEMS



A source of knowledge for sustainable development and global security to lead to fulfilment of human needs through simultaneous socio-economic and technological progress and conservation of the Earth's natural systems.

THEME 3.10
THERMAL POWER PLANTS

Article	Title	Author	Words	Figures
3.1	THERMAL POWER PLANTS	R.A. Chaplin	21505	4
3.10.1	POWER PLANT TECHNOLOGY	R.A. Chaplin	15006	26
3.10.1.1	Power Plant Combustion Theory	R.A. Chaplin	5788	0
3.10.1.2	Nuclear Reactor Theory	R.A. Chaplin	11027	14
3.10.1.3	Thermal Fluid Theory	R.A. Chaplin	7997	12
3.10.1.4	Thermodynamic Theory	R.A. Chaplin	7571	15
3.10.1.5	Power Plant Steam Cycle Theory	R.A. Chaplin	6221	20
3.10.1.6	Exergy Analysis	R.A. Chaplin	8898	22
3.10.1.7	Power Plant Materials	D.H. Lister	5985	2
3.10.1.8	Condition Assessment and Life Extension	R.A. Chaplin	10308	11
3.10.2	PRODUCTION OF STEAM	R.A. Chaplin	13646	10
3.10.2.1	Fossil Fuel Fired Boiler Plant Configuration	R.A. Chaplin	5444	15
3.10.2.2	Fossil Fuel Handling	R.A. Chaplin	6608	6
3.10.2.3	Fossil Fuel Combustion Systems	R.A. Chaplin	9090	10
3.10.2.4	Fossil Fuel Fired Boiler Water-Steam System	R.A. Chaplin	8545	12
3.10.2.5	Fossil Fuel Fired Boiler Air and Gas Path	R.A. Chaplin	11152	28
3.10.2.6	Fossil Fuel Waste Product Handling	R.A. Chaplin	11939	16
3.10.2.7	Fossil Fuel Plant Materials and Chemistry	D.H. Lister	8412	3
3.10.2.8	Nuclear Reactor Configuration	R.A. Chaplin	9228	6
3.10.2.9	Nuclear Reactor Heat Removal	R.A. Chaplin	8989	6
3.10.2.10	Nuclear Reactor Steam Generation	R.A. Chaplin	6909	6
3.10.2.11	Nuclear Reactor Materials and Chemistry	D.H. Lister	10833	9
3.10.3	PRODUCTION OF POWER	R.A. Chaplin	13106	14
3.10.3.1	Steam Turbine Configuration	R.A. Chaplin	4702	20
3.10.3.2	Steam Turbine Impulse and Reaction Blading	R.A. Chaplin	7854	18
3.10.3.3	Steam Turbine Components and Systems	R.A. Chaplin	7827	36
3.10.3.4	Steam Turbine Steam System	R.A. Chaplin	7211	12
3.10.3.5	Steam Turbine Operational Aspects	R.A. Chaplin	9317	30
3.10.3.6	Air-Cooled Heat Exchangers and Cooling Towers	D.G. Kroger	9220	40
3.10.3.7	Gas Turbine Fundamentals	H.I.H. Saravannamutto	5601	15
3.10.3.8	Gas Turbines for Electric Power Generation	H.I.H. Saravannamutto	7003	1
3.10.3.9	Electric Power Generation	R.A. Chaplin	10056	20