Learn about the sources of energy and the environmental consequences

ONR/EPRI/AEP Faculty Workshop

Oregon State University
Corvalis, Oregon

July 20-25, 2009

Production and Consumption of Energy

United States in 2004

- Energy Consumption – 100 Quadrillion BTUs
- Energy Production – 70 Quadrillion BTUs

Generation by fuel types

- Coal
- Petroleum
- Natural Gas
- Nuclear
- Hydroelectric

Coal-Fired Power Plants

- Main source of electricity in most countries
- US has 30% of world resources
- Serious environmental consequences
  - greenhouse gases
  - mercury polluton
- Long time to bring online

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Natural Gas and Oil Power Plants

- Natural gas is plentiful in most regions of the world
- No mercury pollution as for coal plants
- Does contribute to greenhouse gases
- Inexpensive and quick to build

Nuclear Power

- Small amount of material for large power output
  - one gram can produce 1000 MW-day of energy
- No pollution problems
- Serious problem for radioactive waste storage
- Two broad categories
  - Nuclear Fusion
  - Nuclear Fission

Renewable Energy

Wind Energy

- Enormous potential
- Windmills with induction generators

Photovoltaic Energy

- Very costly for startup power production
- Power tracking systems

Fuel Cells

- Presently commercially competitive
- No major environmental problems
- Storing and transporting hydrogen is a concern

Biomass

- Just beginning to emerge as a major energy source

Suggested Program for the Major in Electrical Engineering 2008-2009

Freshman Year

First Semester		Hours	Second Semester		Hours
Freshman Comp I	ENGL 1123	3	Technical Writing	ENGL 1143	3
Calculus I	MATH 1134	4	Calculus II	MATH 2024	4
Engr Appl Lab II	GNEG 1121	1	Engr Appl Lab III for Math	GNEG 2021	1
Computer Appl. Engr	ELEG 1043	3	Inorganic Chemistry	CHEM 1021	1
Intro to Engr. CS&Tech	ELEG1011	1	University Physics Lab I	PHYS 2511	1
Intro to Electrical Engr. Lab.	ELEG1021	1	University Physics I	PHYS 2513	3
Fund of Speech Com	SPCH 1003	3	Chem for Engrs	CHEM 1034	4
Total		16	Total		17

Sophomore Year

First Semester		Hours	Second Semester		Hours
Differential Equations	MATH 2043	3	Network Theory I	ELEG 2023	3
University Physics II	PHYS 2523	3	Circuits Lab	ELEG 2011	1
Univ Physics Lab II	PHYS 2521	1	Thermodynamics I	MCEG2013	3
U.S. to 1876	HIST 1313	3	Statics & Dynamics	CVEG 2454	4
American Government I	POSC 1113	3	Econ. Analy Tech App.	CHEG 2003	3
Humanities Elect.		3	U.S. 1876 to Present	HIST 1323	3
Total		16	Total		17

Junior Year

First Semester		Hours	Second Semester		Hours
Math for Engineers	MATH 3685	5	Electronics I	ELEG 3043	3
Network Theory II	ELEG 3013	3	Electronics Lab	ELEG 4011	1
Logic Circuits	ELEG 3063	3	Professional Engineering I	ELEG 3051	1
Logic Circuits Lab	ELEG 3021	1	Signals & Systems	ELEG 3023	3
Physical Electronics	ELEG 3033	3	Microprocessor Sys Desig	ELEG 3073	3
			Microprocessor Systems Lab	ELEG 3071	1
American Govt. II	POSC 1123	3	Behavioral & Soc. Science		3
Total		18	Total		15

Senior Year

First Semester		Hours	Second Semester		Hours
Electronics II	ELEG 4043	3	Control Systems	ELEG 4073	3
Communicat Theory	ELEG 4003	3	Sr Design & Prof. II	ELEG 4483	3
Sr Design & Prof. I	ELEG 4473	3	Visual & Perf. Arts		3
Energy Conversion	ELEG 4013	3	Elect Engin Lab Elec		1
Electro. Field Theory	ELEG 4033	3	Technical Electives		6
Total		15	Total		16

ELEG 3013. Network Theory II. (3-0) Credit 3 semester hours. Continuation of transient and sinusoidal analysis. Study of average and RMS power, polyphase circuits, complex frequency, frequency response, and magnetic circuits. Prerequisite: ELEG 2023, and MATH 2043.

ELEG 4013. Electromechanical Energy Conversion. (3-0) Credit 3 semester hours. Electric and magnetic devices, force and torque measurements, iron core transformers, single phase and polyphase power circuit analysis. Introduction to per unit system. Prerequisites: MATH 4173 and ELEG 3013.

ELEG 4023. Power Systems Engineering. (3-0) Credit 3 semester hours. Elementary synchronous machines. General considerations of power generation, transmission, distribution and utilization, survey of load flow, faults, transient stability and economic power dispatch. Prerequisite: ELEG 4013.

ELEG 4243. Power Electronics. (3-0) Credit 3 semester hours. Characteristics of solid state power switches, controlled rectifiers and inverters; DC choppers; AC power controllers; applications to power supplies, electric machine drives, HVDC power transmission and space power systems. Prerequisite: ELEG 3043; Prerequisite or co-requisite: ELEG 4013.

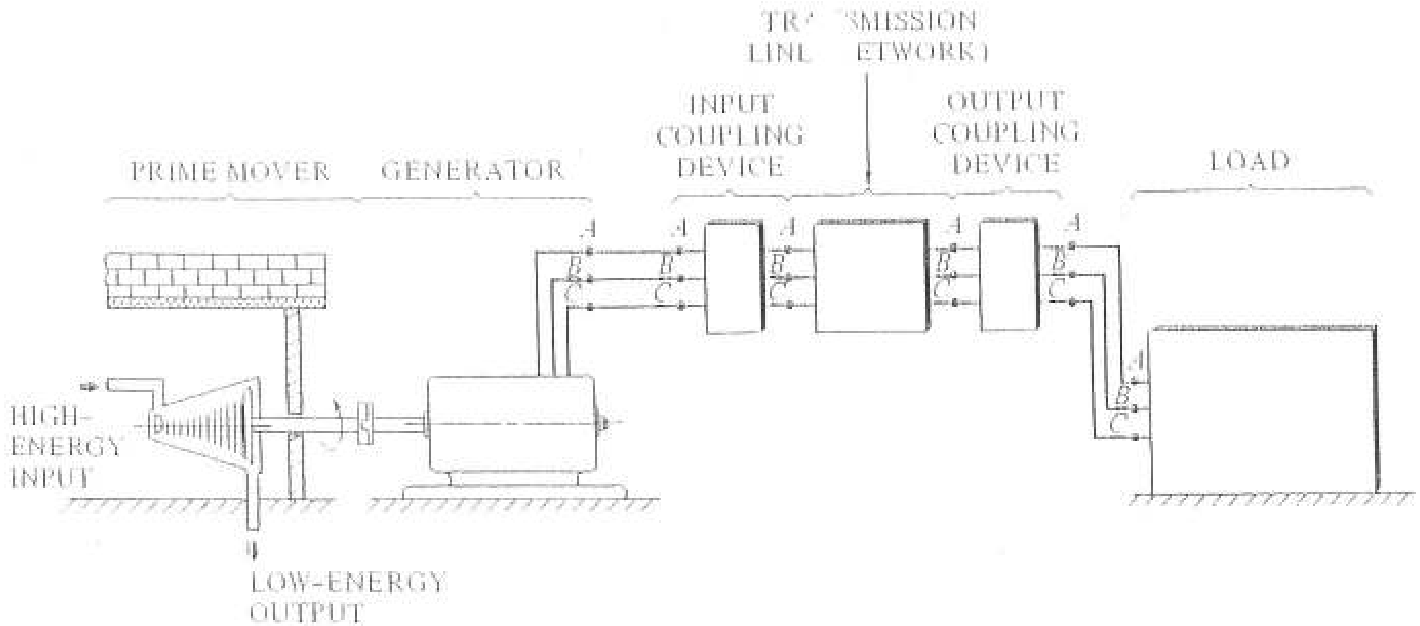

Plate 1 Model Elementary Power System.

Coal
gas
Hydroelectric
Nuclear
wind

Generator output
2300V–
34,500V

Substation Transformer output
110 KV
1000 KV

Transmission Line
Z_L depends on distance

Substation Transformer output
~~22000 V~~ 11KV
~~34,500~~ 138KV
over a distribution system to homes

Local Transformer output
110
208
220V
(distribution transformer)

Three phase (3 ϕ)
Transmission

- **ELECTRICAL ENGINEERING DEPARTMENT**
- **ELECTROMECHANICAL ENERGY CONVERSIONS ELEG-4013**

- **Textbook:** Electric Machinery and Power Systems. Chapman S. T.,
- McGraw Hill. N.Y. 2002. ISBN: 978-0-07-229135-3

- **TOPICS TO BE COVERED**

- **Chapter 1**
- **Rotational Motion**, Newton's Law and Power 2 wks
- **Magnetic Fields and Circuits**. Energy losses in a Ferromagnetic Core
- **Faraday's** and **Lenz's** Laws.
- **Voltage** on a conductor moving in a magnetic field.
- **Force** on a current carrying conductor in a magnetic field.
- **Real, Reactive, and Apparent Power**
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- **Chapter 2**
  2 wks
- **Three-Phase Circuits**
- **Generation of Three-Phase Voltages and Currents**
- **Power in Three Phase**
- **Three Phase Analysis**
- **Chapter 3**
  2 wks
- **Transformers**
- **Ideal Transformers**
- **Transformers**, single phase and three phase, rating, regulation; special types e.g. Current transformers. Problems involving transformer use in power transmission systems. (2 weeks)
- **Equivalent Transformer Circuits**
- **Per Unit System**
- **Voltage Regulation**
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- **Chapter 4**
  2 wks
- **AC Machine Fundamentals**
- **Rotating Magnetic field**
- **Force and Flux**
- **Induced Voltage**

- **Chapter 5**
- **Synchronous Machines** **2 wks**
- **Basic Principles**
- **Synchronous Generators**
- **Synchronous Motors**
- **Starting Synchronous Motors**
- **Generator and Motor Principles**-The rectangular rotation loop**.**
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- **Chapter 7**

- **Induction Motors** **1 ½ wks**
- **Basic Induction Motor**
- **Equivalent circuit**
- **Power and Torque**

- **Chapter 8**

- **DC Motors** **1 ½**
- **Fundamentals of DC Motors**
- **Force, Induced Voltage and Torque**
- **Commutation**
- **Shunt and Series Motors**

- **Power Electronics** **1 ½ wks**
- **Power Electronics** - Introduction. The Diode, Thyristor (PNPN, SCR, GTO etc.)
- **Converters, Inverters**, and **Choppers**. Use of these in motor drives. (1 week)
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- **Expected ABET Outcome**
- a) an ability to design and conduct experiments as well as to analyze and interpret data
- e) an ability to design a system, component or process to meet desired needs
- h) a broad education necessary to understand the impact of engineering solutions in a global and societal context
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

- **ELEG 4013**
- **ENERGY CONVERSIONS**
- **Problem solving using MATLAB**
- Run the program in the EECE computer laboratory
- Directions for using MATLAB
- Click on MATLAB icon, a workspace window should appear
- with three separate areas of
- workspace
- command window
- command history
- Click on file, located in the upper left hand corner and select “new”
- next click on “mfile”
- A new screen appears with title of “untitled”
- Type the following program from page 19 of you textbook in the window
- % m-file: exl_1.m
- % m-file to calculate the flux in example 1-1
- l1 = 0.45;
- l2 = 1.3;
- a1 = 0.01;
- a2 = 0.015;
- ur = 2500;
- u0 = 4*pi*1E-7;
- n = 200;
- i = 1;
- % Calculate the first reluctance
- r1 = l1/ (ur * u0 * a1);
- disp (['r1 = ' num2str(r1)]);
- %Calculate the second reluctance
- r2 = l2 / (ur * u0 * a2);
- disp (['r2 = ' num2str(r2)]);
- % Calculate the total reluctance
- rtot = r1 + r2;
- % Calculate the mmf
- mmf = n * i;
- % Finally, get the flux in the core
- flux = mmf / rtot;
- % Display result
- disp (['Flux = ' num2str(flux)]);
- Now click on “debug” at the top of the display
- next click on “save and run”
- Save your work with an appropriate title and the program automatically compiles and run
- Results should appear in the right command window as follows
- This is a Classroom License for instructional use only.
- Research and commercial use is prohibited.
- Using Toolbox Path Cache. Type "help toolbox_path_cache" for more info.
-
- To get started, select "MATLAB Help" from the Help menu.
- Results of the program should look as follows
- >> r1 = 14323.9449
- r2 = 27586.8568
- Flux = 0.004772
- >>
- Explain your results and compare with hand calculations
- This is the required result as given in you text.
- You have just completed your first MATLAB program.
- Use print window screen to turn in your results to your instructor on Friday October 31 at the start of class. Use your name to save and run your program.