UNIVERSITY OF MINNESOTA
DEPARTMENT OF MECHANICAL ENGINEERING
111 CHURCH STREET S.E.
MINNEAPOLIS, MN 55455

SPRING SEMESTER 2007

ME 8800 — Modern Developments in Mechanical Engineering

(Course No. 51475, 1 cr, S/N only)

Register for this course with Jeanne Sitzmann, 1120 ME

Lecture Series: April 16-19, 2007

PLASMA SPECTROSCOPY

Professor James E. Lawler
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Monday	**April 16, 2007**	**Lecture #1**
		Fundamentals Of Line And Continuum Radiation From Discharge Plasmas
	3:30-5:00 pm	Room 1130 ME
	5:00-5:30 pm	Discussion
Tuesday	**April 17, 2007**	**Lecture #2**
		Resonance Radiation Trapping And The Power Balance Of Non-LTE Discharge Plasmas
	3:30-5:00 pm	Room 1130 ME
	5:00-5:30 pm	Discussion
Wednesday	**April 18, 2007**	**Graduate Seminar — ME/ISyE 8773-8774**
		Lighting Consumes 25% of All Electric Power - How Much Can This Be Reduced?
	03:15 pm	Refreshments, Room 401 Walter DTC
	3:30-4:30 pm	Graduate Seminar: Room 402 Walter DTC
	4:30-5:00	Discussion
Thursday	**April 19, 2007**	**Lecture #3**
	3:30-5:00 p.m.	**Radiation Transport in LTE Discharge Plasmas**
	5:00-5:30	Room 1130
		Discussion

Seminar Coordinator: Prof. Jane H. Davidson, 3101E ME (612-626-9850), jhd@me.umn.edu
Course Secretary: Betsy A. Antinozzi, 1100 ME (612-625-0140), antin003@umn.edu
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Spring Semester 2007
ME 8800 Modern Developments in Mechanical Engineering
(Course No. 51475, **1 cr, S/N only)**

April 16-19, 2007

PLASMA SPECTROSCOPY

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General Outline

This series of lectures is a review of the fundamentals of radiation emission, absorption, and scattering in discharge plasmas. The emphasis is on Lighting Plasmas which occur primarily in atomic gases. Both high pressure (> 1 bar) plasmas which are in Local Thermodynamic Equilibrium (LTE), and low pressure (< 0.01 bar) plasmas which are far from LTE will be covered. Simple concepts and definitions will be used and connected to rigorous equations needed for quantitative modeling and/or diagnostic studies. The general Seminar will be review of existing lighting technologies and a discussion of possible improvements in, or replacement of, these technologies.

Lecture #1

Fundamentals Of Line And Continuum Radiation From Discharge Plasmas

Monday, April 16, 2007
3:30-5:30 p.m.
Room 1130 ME

Abstract

Basic concepts and definitions including absorption and emission of line radiation, Detailed Balance, Einstein A & B coefficients, oscillator strengths, absorption & stimulated emission cross sections will be reviewed. The connection of these atomic parameters with the simple harmonic oscillator model of an atomic resonance will be emphasized. Broadening of spectral lines will be covered including radiative, Doppler, and collisional broadening in the impact approximation and quasi-static approximation limits. Continuum processes including electron + ion Bremsstrahlung, electron + ion Recombination, and electron + atom Bremsstrahlung will be discussed.

Lecture #2

Resonance Radiation Trapping and the Power Balance of non-LTE Discharge Plasmas

Tuesday, April 17, 2007
3:30-5:30 p.m.
Room 1130 ME

Abstract

Resonance radiation dominates (60% to 80%) the power balance of non-LTE discharge plasmas used in modern light sources. Resonance photons are emitted and absorbed 10 to a few 1000 times before reaching the wall of the discharge tube. This Radiation Trapping is a non-local transport process described by the Fredholm integral equation of Holstein and Bibermann. Complete Frequency Redistribution and Partial Frequency Redistribution will be discussed. Analytic, Monte Carlo, and Propagator Function methods for solving radiation trapping problems will be presented. The connection of these solutions to a more complete low pressure discharge model will be given.

Graduate Seminar

ME/IE 8773-8774
Co-Sponsored by the Initiative for Renewable Energy and the Environment
and
ME 8800

Lighting Consumes 25% of All Electric Power - How Much Can This Be Reduced?

Wednesday, April 18, 2007
3:15 pm — Coffee and Cookies, Room 401 Walter DTC
3:30 pm — Graduate Seminar, Room Walter DTC

Abstract

Conservation and efficiency improvements represent a partial response to energy and environmental problems. These can "buy time" for the development of new primary energy sources. Figures of merit for light sources will be introduced. Efficacy or efficiency is important, but there are other performance parameters. Lighting technologies in use today including: Incandescent, Fluorescent (low pressure, glow discharge), Low pressure Na (low pressure discharge), Hg High Intensity Discharge (Hg-HID), High pressure Na (HPS), Metal Halide HID (MH-HID), and Solid State Lighting, will be reviewed. Major R&D issues and prospects for further improvements of these technologies will be discussed.

Lecture #3

Radiation Transport in LTE Discharge Plasmas

Thursday, April 19, 2007
3:30-5:30 p.m.
Room 1130 ME

Abstract

The radiation transport equation for the spectral radiance of a high pressure discharge will be presented and discussed. This equation incorporates the concept of opacity from line and continuum mechanisms. It is used to model the spectral radiance as function of position in a high pressure discharge. Numerical techniques for solving the radiation transport equation and connecting solutions to a more complete high pressure discharge model will be presented.

Biography

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James E. Lawler is the *Arthur and Aurelia Schawlow Professor of Physics* at the University of Wisconsin-Madison. He has a long term interest in quantitative spectroscopy for addressing applied science problems in plasma technology and fundamental problems in astrophysics. Current research activities include: (1) a study of the opacity of Hg plasmas at extreme high pressures (200 to 1000 bar) for lighting technology and (2) a providing basic spectroscopic data for determining the origins of the heavy elements and the chemical evolution of the Galaxy. J. E. Lawler has won the APS Allis Prize and IUPAP Penning Award for his work in Plasma Spectroscopy.