San Jose State University
Department of Mechanical Engineering

ME 130 Applied Engineering Analysis-01

Instructor: Tai-Ran Hsu, Ph.D.

Review for

Final Examination (S2019)

Time: 7:15 – 9:30 AM
Date: Friday, May 17, 2019
Place: Classroom (Room 331), Engineering Building

Format:

Open-book similar to that of Midterm Examination on April 11, 2019

Materials coverage:

1) **Textbook (Chapters 1-9 and 12)**

2) **Slides presented in the classroom (plus those in the condensed versions)**

3) **Home works**

4) **Classroom presentations by the instructor**

Scope of the Final Examination:

60% on Second Half of Chapter 7 (from Section 7.5 on p. 217), Chapter 8, Chapter 9 (topics covered in the condensed version of the slides), and Chapter 12 (topics covered in the condensed version of the slides)

40% on Chapter 1 to the first half of Chapter 7 (to p.216), including the parts NOT covered in the midterm exam on April11, 2019, e.g., Chapters 4, 5 and 6.

Chapter 7
(PP. 217-242)

- **Familiar with the solution methods of the first-order differential equations**
- **Fourier Law of heat conduction in one and multi-dimensions**
- **Newton's cooling law**
- **Heat flow in heat spreaders with rectangular, saw-tooth cross sections**
- **Derive equations for coupled heating and cooling of small solids in environmentally controlled chambers**

Chapter 8
Second Order Ordinary Differential Equations and Applications

- Typical form of 2nd order homogeneous and non-homogeneous differential equations:

  Homogeneous equation: $$\frac{d^2u(x)}{dx^2} + a\frac{du(x)}{dx} + bu(x) = 0$$

  Non-homogeneous equation: $$\frac{d^2u(x)}{dx^2} + a\frac{du(x)}{dx} + bu(x) = g(x)$$

- Solution method with $u(x) = e^{mx}$, leading to 3 cases:
  $a^2 - 4b > 0$, $a^2 - 4b < 0$ and $a^2 - 4b = 0$ for homogeneous equations

- Solution method with $u(x) = u_h(x) + u_p(x)$ for non-homogeneous equation, know how to derive $u_h(x)$ and $u_p(x)$

- Application of homogeneous equations for free-vibration analysis with and without damping – physical interpretation of analytical results?

- Consequences of excessive mechanical vibrations to machines and devices

- Application of non-homogeneous equations for forced vibration analysis:
  - Resonant vibration – engineering consequences
  - Near-resonant vibration – engineering consequences

- Modal analysis – why it is important and what are involved in the analysis?

Chapter 9

Introduction to Partial Differential Equations

What are partial differential equations?

Under what situations one needs to use partial differential equations in ME analysis?

What is the principle of "Separation of Variables?"

Why transverse vibration of "strings" is an important subject of ME analysis?

Simple math models of transverse vibrations of strings

The partial differential equation and solution for transverse vibration of strings (familiar with the Example in Section 9.7.2)

Modal analysis of vibrating strings

Why modal analysis?

Natural frequencies of various modes of a string (Section 9.7.4)

Chapter 12 Introduction to Statistics

- What is statistics, and what is the scope of statistics?
- The histogram – what does it tell and how to establish it?
- The "**mode**," the "**mean**," "**median**," "**variance**," and "**standard deviation**" of statistical datasets, and their physical significances
- Method of determining: "mean," "median" and "standard deviation"
- The "normal distribution curves" – what do they represent?
- The "normal distribution function" – what is it?
- Why "normal distribution function" is fundamentally significant in statistical analysis?
- Why "statistical process control" (SPC) is a realistic and effective way of quality control of products in mass production?
- What tools do SPC provide?
- What are "control charts?" What are the control charts presented in this course and how are they derived?
- How would engineers use these control charts in quality control in their production?

Parts NOT Covered in the Midterm Examination on April11, 2019

Chapter 4
Linear Algebra and Matrices

- Why matrices- a component of linear algebra is a critical tool for modern engineering analysis?
- Matrices and determinants
- Different forms of matrices
- Arithmetic operations of matrices: +, -, and x
- **Inverse of matrices**
- **Solution of large number of simultaneous equations using**
  - **Inverse matrix method, and**
  - **Gaussian elimination method**
- **Why large number of simultaneous equations?**

Chapter 5
Introduction to Laplace Transform

- What is Laplace transform and why it is included in this course?

- Under what conditions can a function be transformed from a "variable domain" to a "parametric domain?"

- Laplace transform of functions and derivatives

- What is inverse Laplace transform, and why?

- Inverse Laplace transform by "partial fractions" method

- Inverse Laplace transform by "convolution theorem"

- Using Laplace transform solving differential equations:

  - Necessary conditions for using this technique
  - General solution procedure
  - The advantages of using Laplace transform in solving differential equations

Chapter 6
Overview of Fourier Series

● What is Fourier series and why?

● What are necessary conditions to derive a Fourier series?

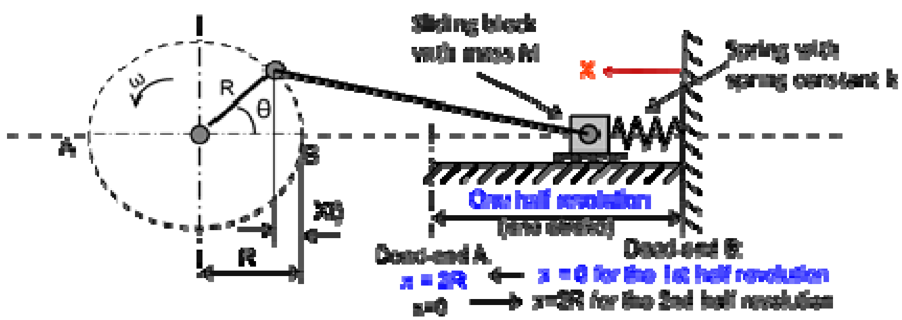
● Mathematical expressions of Fourier series

● Applications of Fourier series in engineering analyses

● What is "convergence" of Fourier series?

● How Fourier series converge for:
  ● continuous functions, and
  ● piece-wise continuous functions?

● Familiar with application of Fourier series in such cases as in the following case (motion, forces, ω or RPM to be avoided, and the induced cyclic spring force?):



NOTE on Graded Homeworks

The Instructor and his Grader will make teir sincere efforts in delivering the following:

Graded Homework No. 4 on Chapters 7 and 8, and Homework No. 5 on Chapter 9 will be available for pick-up inside Room 117 between 9 AM to 12:00 noon on Monday, May 13, 2019.

Graded Homework No. 6 on Chapter 12 will be available for pick up at 7:05 AM In room 133 before the final exam on Friday, May 17, 2019.

GOOD LUCK