Essentials of Applied Dynamic Analysis
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1 OVERALL COMMENTS

This book provides an excellent introduction to system dynamics and understanding the dynamic response of structures. The author begins from basic principles and builds the reader's understanding in a relatively rapid manner. He does not immediately simplify the approach and ignore the non-trivial issues. He introduces the complexities and tells the reader where they will be dealt with in detail in later chapters. Instead of talking about square boxes with M's, squiggly lines with K's, and dashpots with C's, this author talks about real problems with excellent examples and helps the reader to see how to apply fundamental analysis to real systems.

It is important to note the focus of the text is marine engineering and the vast majority of examples and illustrations focus on oil exploration and production platforms in the ocean. There is a great deal of discussion of topics such as the support of flares, sea states, wind loads, seismic excitations and other topics unique to this specific application. However, this should not detract from the outstanding coverage of basic principles including multiple degrees of freedom, damping, complex loading, strength of materials and other fundamental topics.

The author's approach is to use a number of short chapters on specific topics. He uses this approach to build knowledge in small steps. One wonders if these short treatments are sufficient for those not familiar with the topics. Clearly this book could be a great refresher, but it may be a challenge as the first text on these topics.

Later chapters, after Chapter 6, are very heavily focused on ocean structures even when illustrating basic concepts. For those dealing with these sort of structures this is very helpful. For the more general audience, this may not be as helpful in understanding some of the basic concepts of dynamics and analysis.

For those working on the dynamics of ocean structures or planning to work in this area this would be an excellent text to begin. The numerous references would also be helpful for detailed analysis and more difficult topics. For a student or those unfamiliar with system dynamics the first 14 chapters provide a very good introduction to the topics with both the theoretical frame work and some good practical insight for marine engineering type structures.

Toward the end of the text one chapter that stands out is Chapter 17, Fatigue Assessment. The author encloses a lot of information with coverage of several different methods of accounting for fatigue and crack propagation. A novice to this topic area may be left with a lot of alternative approaches and it may be difficult to grasp and determine what is useful and appropriate especially for non-offshore problems. Since there are whole text books devoted to this topic, it is not surprising that the author found a challenge in covering it in one chapter.

Below are comments and notes for each of the chapters to better describe the book and its value.

2 CHAPTER 1 — INTRODUCTION

The author provides good examples with coverage of a wide range of issues. His examples and descriptions of excitation include sloshing fluids, earthquakes and trains to name a few. He does a good job giving the student/reader a perspective of the wide variety of dynamic problems and their importance. As one would expect relating dynamics to risk, a great deal of this material deals with resonances and damage. At the end of the chapter the author does a good job illustrating when the complex topics introduced with be covered in later chapters.

One error, the reference to Sec. 1.2 in the first paragraph under 1.4 Solving Dynamic Problem, should be 2.2.

3 CHAPTER 2 — GOVERNING EQUATION OF MOTIONS

Like most such texts the author starts with a single degree of freedom problem with a typical simple diagram.

He does an excellent job describing how Hamilton's principle is used as a tool with Newton's law to create an equation of motion. He provides a good example multi-degree of freedom problem and takes it to the point of showing the matrix formulation. At first sight this seems like a rapid progression, but it provides a good foundation for later treatments and helps the student/reader be prepared for what comes later.

4 CHAPTER 3 — FREE VIBRATIONS FOR A SINGLE-DEGREE-OF-FREEDOM (SDOF) SYSTEM—TRANSLATIONAL OSCILLATIONS

This is the typical approach to describing single degree of freedom systems and the solutions. It is clear and well done. I really like the discussion of modeling beams and stiffness documentation. The discussion of

damping is well done. It covers the topic well in terms of the magnitude of damping and its effects.

5 CHAPTER 4 — PRACTICAL EIGENANALYSIS AND STRUCTURAL HEALTH MONITORING

This is a good approach. The author uses standard terminology in the field. He is forced to explain this to the reader, but it is much better than using simple terms that are required to understand those terms like eigenvalue which are used as a standard in the field. The author does an excellent job developing and documenting the analysis of beams by showing the basic principles and providing a chart of eigenvalues for several beam configurations.

His treatment of equivalent mass and stiffness is quite comprehensive and should be useful for many readers.

The treatment of symmetry, while an important topic, is not presented in great depth. The reader will certainly understand the basic concepts. There is no discussion of resolving symmetry problems or a reference to a more detailed discussion later in the text.

6 CHAPTER 5 — SOLVING EIGENPROBLEM FOR CONTINUOUS SYSTEMS: RAYLEIGH ENERGY METHOD

This chapter presents a good discussion of the Rayleigh Method with good examples of its application. The author does a good job of explaining and demonstrating the importance of choosing a good deflection shape to get accurate results.

7 CHAPTER 6 — VIBRATION AND BUCKLING UNDER AXIAL LOADING

There is a problem with definition under Equation 6.9 — λ is said to be a buckling load, but by definition it is dimensionless. Overall this chapter is a good introduction to buckling formulation and problems. This is definitely not a thorough treatment, but it provides a foundation for later treatment. The example provided provides a set of interesting conditions for higher order modes. This should cause the reader/student to think about the state of loading throughout a structure and to realize the complexity of such problems.

8 CHAPTER 7 — EIGENFREQUENCIES FOR NON-UNIFORM BEAMS, SHALLOW AND DEEP FOUNDATIONS

This is a very short chapter that introduces the concept of foundation effects. The example shown has an unexplained factor R, which is disconcerting for the reader.

9 CHAPTER 8 — DETERMINISTIC AND STOCHASTIC MOTIONS

This chapter provides a good introduction to the concepts of time signals and their characteristics. With the examples provided the reader can have a good understanding of the important characteristics in categorizing signals. It might have been helpful to have had an example illustrating how properly categorizing a signal or forcing function is important.

10 CHAPTER 9 — TIME DOMAIN TO FREQUENCY DOMAIN: SPECTRUM ANALYSIS

A good introduction to spectral analysis is presented in a very few pages. The major elements are represented.

The emphasis is on describing the Fourier series and its many representations in terms of parameters and graphs. There is not an in depth treatment of the statistics or statistical parameters for characterizing signals or motion.

11 CHAPTER 10 — STATISTICS OF MOTIONS AND LOADS

The chapter discusses basic concepts of statistics and statistical distributions. Gaussian, Weibull, Rayleigh and Poisson distributions are covered. The concepts are discussed in terms of characterizing ocean waves for the most part. This was the first chapter for which there were not sufficient examples to help the reader/student clearly understand the application of the concepts presented.

12 CHAPTER 11 — FORCED VIBRATIONS

This chapter presents a comprehensive discussion of forced vibration. It covers the basic concepts from simple harmonic forcing functions to random functions. The examples and the way in which much of the material is presented are oriented toward ocean structures and their loading. The segment on page 147 dealing with how to handle dynamic loading on ocean structures is very useful to those working with such structures. The definition of wave related transfer functions and the example on page 148 again are very useful to those working with ocean structures. The example does an excellent job of illustrating the basic concepts of period of static versus dynamic loading.

In segments of the chapter terms like “jacket” and “top side” may be unfamiliar to the reader. A short

explanation of ocean structures and the terminology may have been helpful.

The author does an excellent job of presenting the concepts of transfer functions and coherence. This is done in a logical and intuitive fashion that should aid the reader in understanding the underlying concepts. Instead of just presenting the functions, the author takes the reader through a process that highlights the concepts behind the functions. Section 11.5 is particularly well done.

It would have been helpful if the author had spent more time explaining the concepts of noise. This is discussed in the final page of the chapter. While this treatment is accurate and highlights important concepts, it may be too short for the reader to understand the importance the impact of noise.

13 CHAPTER 12 — CALCULATION OF ENVIRONMENTAL LOADING BASED ON POWER SPECTRA

This chapter focuses on loading calculations for wave and wind loads. There are also descriptions of loading spectra for ice impacts and earthquakes. As in the preceding chapter, the applications used for examples and to illustrate basic principles are ocean structures such as drilling platforms. The author is very thorough in his explanation of the basic principles and the concepts of the theories behind some of the loading functions. In many instances the complex representations are finally expressed in a simple formula based on rules of thumb or approximations based on typical circumstances.

Two typographical errors were noted in this chapter:

- In the first paragraph on page 175, "below" should be "blow."
- On page 179 under equation 12.25, "gis" should be "g is."

The treatment of ocean waves and wind loading by the author is extensive. While I am not an expert in these areas, the discussions seem comprehensive and provide the reader a lot of information and numerous references. The ice loading segment was interesting and quite enlightening. The treatment on earthquake loading was short, but provided an introduction knowing there was a more in depth treatment in a later chapter.

14 CHAPTER 13 — VIBRATION OF MULTI-DEGREES-OF-FREEDOM SYSTEMS

This chapter provides a very thorough discussion of multiple degree of freedom problem formulations and solutions. It provides a sound foundation for the reader in understanding and working with such problems.

There is a lot of good information about different solution methods. Both implicit and explicit integration methods are discussed. The author describes several classic methods and provides good references to the methods not discussed. Overall this is a very comprehensive introduction to the topic that should provide a lot of insight to the reader.

There seems to be a word omission in the first line of the definition of terms under Equation 13.26. In the second paragraph on page 221, the second sentence has a phrase "a Sec. 15, a . . ."; it seems like something is missing or the reference is not complete.

15 CHAPTER 14 — DAMPING

This is the most engaging chapter in the book. It presents a thorough discussion of damping and damping equivalences. The author does an excellent job of presenting the theory of energy dissipation and the characterization of this loss in terms of different types of damping. The reader can find a very well done explanation of the loss mechanism and how the damping can be represented in the basic equations of motion.

In addition, the author provides very useful rules of thumb and tables of realistic values for damping for engineering structures. There are discussions and tables specific to ocean structures, but there is also a lot of material relevant to a wide range of vibration issues. On page 242 in the third paragraph "nature Frequency" should be "natural frequency."

16 CHAPTER 15 — NONLINEAR DYNAMICS

This chapter presents a comprehensive treatment of the strength of materials related to stress–strain behavior and nonlinearities in materials and material sample tests. Overall, this chapter presents the concepts and the principles behind nonlinear behavior and the solution of the equations of motion. It provides an excellent introduction to the topic. To apply these techniques, one would have to have additional knowledge. Perhaps the author assumes the reader will be using a finite element code that has implemented these techniques and only an introduction to provide a basic understanding is needed.

There is extensive discussion of the effects of nonlinearities on dynamic equations and the solutions of these equations. Beam strain hardening and strain softening effects are discussed in some detail. Tables of changes in the natural period are provided due to these changes in material properties. The effects of large

deformations are also discussed with a good example of a vertical column. The author discusses in some detail snap through and snap-back phenomena and how they can be predicted. In the final segment the author discussed load and displacement control methods of solving nonlinear dynamic systems of equations. While not describing the details of such methods the basic premise is present and very simple examples are used to illustrate the basic approach.

17 CHAPTER 16 — STRUCTURAL RESPONSE DUE TO SEISMIC EXCITATIONS

This chapter provides a good introduction to ground vibration and some of the considerations related to seismic activity in building and structural design. As with much of this text, the focus is on ocean structures such as drilling or production platforms. The discussion of excitation period and response utilizes concepts of transient and steady-state response along with stiffness and damping controlled regimes without using such terms. For the reader who has gone through the previous chapters, this may be disappointing to not utilize the concepts and good fundamental foundation provided previously. However, for those going directly to this chapter there is no need to understand the details behind modal response, isolation and frequency response.

The author provides an insightful discussion of soil effects and effects of multiple layers of material to provide a good base for the following analysis. There is a short, but useful, discussion of ground motions and the effects on extended structures. This is helpful in understanding issues with respect to damage and failure in such structures.

The author does an outstanding job presenting some of the "rules of thumb" related to seismic periods, duration and magnitude to provide a context for consideration of the possible impact on structures. Typical spectra envelopes are presented along with a discussion of when deterministic and statistical approaches should be used. Several different methods are discussed for computing the maximum or representative response in the system. The strengths and weaknesses of these methods are discussed and compared with rough estimates of potential errors in the computer response amplitudes. Other effects such as ice on a drilling or production ocean platform are discussed. Though the general effects are noted, there is no discussion of analysis behind these results.

While the author is talking about a broad topic that does not permit comprehensive coverage technically, it would have been nice to have at least one example illustrating the analysis process and some of the concepts and simplifications noted.

18 CHAPTER 17 — FATIGUE ASSESSMENT

This chapter begins with a discussion of different methods for fatigue analysis or assessment. Utilizing the references, the reader will be able to understand what is being presented, but it will be difficult without studying the references for some time. This is the most challenging chapter in the book for the reader. There is a lot presented in an often terse fashion with all the discussion left to references. For those familiar with fatigue analysis, this will not be a major problem. For those having their first exposure to fatigue analysis methods and concepts this will be a very difficult chapter. Toward the later portions of the chapter the discussion lists numerous alternatives and empirical approximations for the reader to consider. While such information is useful, the reader will have a hard time determining what is useful and provides real value.

More practical examples would have been helpful for the reader.

There is only one example in this chapter and this is very difficult for the reader to understand and apply in a realistic way. A few simple examples would have been very helpful for the novice. Figure 17.11 was particularly frustrating. It appears to be a color chart presented in grayscale. It is very difficult for the reader to understand other than the items identified by the author.

The fracture mechanics segment is well done and comprehensive in defining and illustrating the basic principles. The segment on FE modeling is limited. The author defines some of the most significant concepts and difficulties, but provides little else in the one page presentation.

19 CHAPTER 18 — HUMAN BODY VIBRATIONS

This chapter presents a very brief introduction to whole body vibration. It describes some of the basic principles and concepts of human discomfort due to vibration. Allowable magnitudes of acceleration are described in terms of international standards and recommendations. The reader is given some sources of information and basic guidelines for whole body vibration. Detailed analysis is not provided. This chapter only discusses potential discomfort, not injury.

20 CHAPTER 19 — VEHICLE–STRUCTURE INTERACTION

This chapter presents a general discussion of the topic. It does not discuss the details of interactions or the interface between vehicle and ship models. This chapter is more of an overview than a detailed technical presentation. The primary focus of this discussion is vehicles on ships. For someone new to the topic it would provide a good starting point with some references for more detailed treatments. The author introduces the basic concepts of different levels of vehicle modeling details depending on the frequency range of interest and the types of interaction.

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