

## Chapter 2 : Pressure and Head

- 2.1 a. From eqn. 2.4 :  $p_2 - p_1 = -\rho g(z_2 - z_1)$  and taking sea level as datum point 1, then :  
 $p_1 = 0 \text{ Nm}^{-2}$ ,  $\rho = 1002 \text{ kgm}^{-3}$ ,  $g = 9.81 \text{ ms}^{-2}$ ,  $z_2 = -2000 \text{ m}$  and  $z_1 = 0 \text{ m}$ .  
 $\Rightarrow p_2 - 0 = -1002 \times 9.81 \times (-2000 - 0)$ ,  $\therefore p_2 = 19.66 \text{ MNm}^{-2}$

- b. From eqn. 1.12, we know  $K = \rho \frac{dp}{dz}$  and from eqn. 2.17,  $p = \rho g z$  giving :

$\rho^2 g dz = K dp$ . If it is assumed that  $z$  is measured from the surface and is negative as depth increases, and that  $K$  is constant over small pressure ranges, we can then integrate

$$\int_{z_1}^{z_2} \frac{g}{K} dz = - \int_{p_1}^{p_2} \frac{1}{\rho^2} dp \Rightarrow \left[ \frac{gz}{K} \right]_{z_1}^{z_2} = \left[ \frac{1}{\rho} \right]_{p_1}^{p_2}$$

Since we know that  $z_1 = 0 \text{ m}$  then,  $\frac{gz}{K} = \frac{1}{\rho_2} - \frac{1}{\rho_1} \Rightarrow p_2 = \frac{K\rho_1}{\rho_1 g z + K}$

Integrating, NB  $\int \frac{1}{1+ax} dx = \frac{1}{a} \ln(1+ax)$

$$\Rightarrow p_2 - p_1 = -\rho g \frac{K}{\rho_1 g} \ln \left[ 1 + \frac{\rho_1 g z}{K} \right]_{z=0}^{z_2} \Rightarrow p_2 - p_1 = -K \ln \left( 1 + \frac{\rho_1 g z_2}{K} \right)$$

We know that  $p_1 = 0 \text{ Nm}^{-2}$ ,  $K = 2.05 \times 10^9 \text{ Nm}^{-2}$ ,  $\rho_1 = 1002 \text{ kgm}^{-3}$  and  $z_2 = -2000 \text{ m}$ , hence :

$$p_2 - 0 = -2.05 \times 10^9 \ln \left[ 1 + \frac{1002 \times 9.81 \times (-2000)}{2.05 \times 10^9} \right] \therefore p_2 = 19.75 \text{ MNm}^{-2}$$

- 2.2 a. From eqn. 2.4 :  $p_2 - p_1 = -\rho g(z_2 - z_1)$ . Taking the free surface as datum point 1 then,  $p_1 = 0 \text{ Nm}^{-2}$ ,  $\rho = 1000 \text{ kgm}^{-3}$ ,  $g = 9.81 \text{ ms}^{-2}$ ,  $z_2 = -12 \text{ m}$  and  $z_1 = 0 \text{ m}$ .  
 $\therefore p_2 = 117.72 \text{ kNm}^{-2}$
- b. From eqn. 2.16 :  $p = \rho gh + p_{\text{atm}}$ , ie Absolute pressure = Gauge pressure + Atmospheric pressure. Here, gauge pressure =  $117720 \text{ Nm}^{-2}$  and atmospheric pressure =  $101000 \text{ Nm}^{-2}$ ,  $\therefore$  **Absolute pressure =  $218.72 \text{ kNm}^{-2}$**

- 2.3 a. Specific gravity of oil =  $\frac{\rho_{\text{oil}}}{\rho_{\text{H}_2\text{O}}} \Rightarrow 0.8 = \frac{\rho_{\text{oil}}}{1000} \Rightarrow \rho_{\text{oil}} = 800 \text{ kgm}^{-3}$

From eqn. 2.17 :  $p = \rho gh$ , where  $p = 120 \times 10^3 \text{ Nm}^{-2}$ ,  $\rho = 800 \text{ kgm}^{-3}$ ,  $g = 9.81 \text{ ms}^{-2}$ ,  $\Rightarrow 120 \times 10^3 = 800 \times 9.81 \times h$ ,  $\therefore h = 15.3 \text{ m}$

- b. As before,  $p = 120 \times 10^3 \text{ Nm}^{-2}$  and  $g = 9.81 \text{ ms}^{-2}$ , however,  $\rho = 1000 \text{ kgm}^{-3}$ .

From eqn. 2.17 :  $p = \rho gh \Rightarrow 120 \times 10^3 = 1000 \times 9.81 \times h$

$\therefore h = 12.2 \text{ m}$

- 2.4 We know that  $1 \text{ bar} = 1 \times 10^5 \text{ Nm}^{-2}$ .

From eqn. 2.4 :  $p_2 - p_1 = -\rho g(z_2 - z_1)$ . Taking the free surface as datum point 1 :  
 $p_2 = 1 \times 10^5 \text{ Nm}^{-2}$ ,  $p_1 = 0 \text{ Nm}^{-2}$ ,  $\rho = 600 \text{ kgm}^{-3}$ ,  $g = 9.81 \text{ ms}^{-2}$  and  $z_1 = 0 \text{ m}$ .

# Douglas Fluid Mechanics 5th Edition Solution

**Nelson Enrique Barros Galvis**



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**Geomechanics, Fluid Dynamics and Well Testing, Applied to Naturally Fractured Carbonate Reservoirs** Nelson Enrique Barros Galvis, 2018-05-02 This thesis presents an important step towards a deeper understanding of naturally fractured carbonate reservoirs NFCRs It demonstrates the various kinds of discontinuities using geological evidence mathematical kinematics model and computed tomography and uses this as a basis for proposing a new classification for NFCRs Additionally this study takes advantage of rock mechanics theory to illustrate how natural fractures can collapse due to fluid flow and pressure changes in the fractured media The explanations and mathematical modeling developed in this dissertation can be used as diagnostic tools to predict fluid velocity fluid flow tectonic fracture collapse pressure behavior during reservoir depleting considering stress sensitive and non stress sensitive with nonlinear terms in the diffusivity equation applied to NFCRs Furthermore the book presents the description of real reservoirs with their field data as the principal goal in the mathematical description of the realistic phenomenology of NFCRs

*Practical Hydraulics* Melvyn Kay, 1998-10-01 Practical Hydraulics approaches the subject from basic principles It is clearly written and includes many illustrations and examples It will appeal to a wide range of professionals and students needing an introduction to the subject

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Basic Hydrodynamics A. C. Thompson, 2013-09-17 Basic Hydrodynamics explores the application of computers to problem solving involved in fluid flow This book contains 5 chapters that cover the use of BASIC programming language in hydrodynamic problems and some programs with graphic output as well as some simple finite difference finite element and

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Library Board of Western Australia,1966      Spectral Methods in Fluid Dynamics Claudio Canuto,M.Yousuff Hussaini,Alfio Quarteroni,Thomas A., Jr. Zang,2012-12-06 This is a book about spectral methods for partial differential equations when to use them how to implement them and what can be learned from their of spectral methods has evolved rigorous theory The computational side vigorously since the early 1970s especially in computationally intensive of the more spectacular applications are applications in fluid dynamics Some of the power of these discussed here first in general terms as examples of the methods have been methods and later in great detail after the specifics covered This book pays special attention to those algorithmic details which are essential to successful implementation of spectral methods The focus is on algorithms for fluid dynamical problems in transition turbulence and aero dynamics This book does not address specific applications in meteorology partly because of the lack of experience of the authors in this field and partly because of the coverage provided by Haltiner and Williams 1980 The success of spectral methods in practical computations has led to an increasing interest in their theoretical aspects especially since the mid 1970s Although the theory does not yet cover the complete spectrum of applications the analytical techniques which have been developed in recent years have facilitated the examination of an increasing number of problems of practical interest In this book we present a unified theory of the mathematical analysis of spectral methods and apply it to many of the algorithms in current use      **Applications of Energy Harvesting**

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Computer Modeling Applications for Environmental Engineers Isam Mohammed Abdel-Magid Ahmed,Mohammed Isam Mohammed Abdel-Magid,2017-07-06 Computer Modeling Applications for Environmental Engineers in its second edition incorporates changes and introduces new concepts using Visual Basic NET a programming language chosen for its ease of comprehensive usage This book offers a complete understanding of the basic principles of environmental engineering and integrates new sections that address Noise Pollution and Abatement and municipal solid waste problem solving financing of waste facilities and the engineering of treatment methods that address sanitary landfill biochemical processes and combustion and energy recovery Its practical approach serves to aid in the teaching of environmental engineering unit operations and processes design and demonstrates effective problem solving practices that facilitate self teaching A vital reference for students and professional sanitary and environmental engineers this work also serves as a stand alone problem solving text with well defined real work examples and explanations

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*Transactions and Notes of the Concrete Institute* ,1964      Fluid Mechanics and Fluid Power – Contemporary

Research Arun K. Saha, Debopam Das, Rajesh Srivastava, P. K. Panigrahi, K. Muralidhar, 2016-09-20 This volume comprises the proceedings of the 42nd National and 5th International Conference on Fluid Mechanics and Fluid Power held at IIT Kanpur in December 2014 The conference proceedings encapsulate the best deliberations held during the conference The diversity of participation in the conference from academia industry and research laboratories reflects in the articles appearing in the volume This contributed volume has articles from authors who have participated in the conference on thematic areas such as Fundamental Issues and Perspectives in Fluid Mechanics Measurement Techniques and Instrumentation Computational Fluid Dynamics Instability Transition and Turbulence Turbomachinery Multiphase Flows Fluid Structure Interaction and Flow Induced Noise Microfluidics Bio inspired Fluid Mechanics Internal Combustion Engines and Gas Turbines and Specialized Topics The contents of this volume will prove useful to researchers from industry and academia alike **The Mathematics of Reservoir Simulation** Richard E. Ewing, 2014-12-01 This book describes the state of the art of the mathematical theory and numerical analysis of imaging Some of the applications covered in the book include computerized tomography magnetic resonance imaging emission tomography electron microscopy ultrasound transmission tomography industrial tomography seismic tomography impedance tomography and NIR imaging **Books and Pamphlets, Including Serials and Contributions to Periodicals** Library of Congress. Copyright Office, 1968 **Water Resources in the Built Environment** Colin A. Booth, Susanne M. Charlesworth, 2014-03-31 Water management is a key environmental issue in controlling of floods and reducing droughts This book provides analysis of the main issues offering solutions and describing good practice Water Resources for the Built Environment management issues and solutions develops an appreciation of the diverse complex and current themes of the water resources debate across the built environment urban development and management continuum The integration of physical and environmental sciences combined with social economic and political sciences provide a unique resource useful to policy experts scientists engineers and subject enthusiasts By taking an interdisciplinary approach water resources issues and impacts on the built environment are presented in the inventive and strategic setting of considering the constraints of delivering potable water to an ever demanding society who at the same time are increasingly aware of living in an urban landscape where excessive surface water creates a flood threatened environment hence the need to portray a balance between too little vs too much This unique approach to the water resources debate presents a multifaceted collection of chapters that address the contemporary concomitant issues of water shortage and urban flooding and proffers solutions specifically for the built environment The book is structured into three parts the first part Sections 2 3 and 4 addresses management issues and solutions to minimise water shortages and provide water security for society whilst the second part of the book Sections 5 and 6 addresses management issues and solutions to control excessive rainfall and minimise flooding impacts The third part Section 7 contextualises the issues of the earlier sections within international case studies from the developing world *Handbook of Computational Fluid Mechanics* Roger

Peyret,1996 This handbook covers computational fluid dynamics from fundamentals to applications This text provides a well documented critical survey of numerical methods for fluid mechanics and gives a state of the art description of computational fluid mechanics considering numerical analysis computer technology and visualization tools The chapters in this book are invaluable tools for reaching a deeper understanding of the problems associated with the calculation of fluid motion in various situations inviscid and viscous incompressible and compressible steady and unsteady laminar and turbulent flows as well as simple and complex geometries Each chapter includes a related bibliography Covers fundamentals and applications Provides a deeper understanding of the problems associated with the calculation of fluid motion     Ingenium Mark

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