

A diagram showing a circle with a center point. A line segment, representing a radius, extends from the center to the circumference. The center is labeled with a small circle containing the letter 'C'.

Example 4.4  
 % Example body-fixed vectors:  
 %  $\mathbf{r}_1 = [0.15; 0]; \mathbf{r}_2 = [0; 0.15]; \mathbf{r}_3 = [0; 0]$   
 % and unit files  
 %  $\mathbf{u}_1 = [1; 0; 0]; \mathbf{u}_2 = [0; 1; 0]; \mathbf{u}_3 = [0; 0; 1]$   
 % Define spring-damper:  
 %  $L = 0.15; k = 10; d = 5; c = 2;$   
 % Compute A matrices  
 %  $\mathbf{A}_1 = \mathbf{A}(\text{matlab}(\phi)); \mathbf{A}_2 = \mathbf{A}(\text{matlab}(\theta));$   
 % Compute global components of  $\mathbf{s}$ :  $\mathbf{A}_1 \mathbf{s}$   
 %  $\mathbf{s}_1 = \mathbf{A}_1^{-1} \mathbf{s}; \mathbf{A}_1 \text{ local}; \mathbf{s}_2 = \mathbf{A}_2^{-1} \mathbf{s}; \mathbf{A}_2 \text{ local};$   
 % Compute global coordinates of points A  
 %  $\mathbf{r}_1 = \mathbf{r}_1 + \mathbf{s}_1; \mathbf{r}_2 = \mathbf{r}_2 + \mathbf{s}_2;$   
 % Compute global coordinates of points B  
 %  $\mathbf{r}_3 = \mathbf{r}_3 + \mathbf{s}_3;$   
 % Compute global coordinates of points C  
 %  $\mathbf{r}_4 = \mathbf{r}_4 + \mathbf{s}_4;$   
 % Compute global coordinates of points D  
 %  $\mathbf{r}_5 = \mathbf{r}_5 + \mathbf{s}_5;$   
 % Compute global coordinates of points E  
 %  $\mathbf{r}_6 = \mathbf{r}_6 + \mathbf{s}_6;$   
 % Compute global coordinates of points F  
 %  $\mathbf{r}_7 = \mathbf{r}_7 + \mathbf{s}_7;$   
 % Compute global coordinates of points G  
 %  $\mathbf{r}_8 = \mathbf{r}_8 + \mathbf{s}_8;$   
 % Compute global coordinates of points H  
 %  $\mathbf{r}_9 = \mathbf{r}_9 + \mathbf{s}_9;$   
 % Compute global coordinates of points I  
 %  $\mathbf{r}_{10} = \mathbf{r}_{10} + \mathbf{s}_{10};$   
 % Compute global coordinates of points J  
 %  $\mathbf{r}_{11} = \mathbf{r}_{11} + \mathbf{s}_{11};$   
 % Compute global coordinates of points K  
 %  $\mathbf{r}_{12} = \mathbf{r}_{12} + \mathbf{s}_{12};$   
 % Compute global coordinates of points L  
 %  $\mathbf{r}_{13} = \mathbf{r}_{13} + \mathbf{s}_{13};$   
 % Compute global coordinates of points M  
 %  $\mathbf{r}_{14} = \mathbf{r}_{14} + \mathbf{s}_{14};$   
 % Compute global coordinates of points N  
 %  $\mathbf{r}_{15} = \mathbf{r}_{15} + \mathbf{s}_{15};$   
 % Compute global coordinates of points O  
 %  $\mathbf{r}_{16} = \mathbf{r}_{16} + \mathbf{s}_{16};$   
 % Compute global coordinates of points P  
 %  $\mathbf{r}_{17} = \mathbf{r}_{17} + \mathbf{s}_{17};$   
 % Compute global coordinates of points Q  
 %  $\mathbf{r}_{18} = \mathbf{r}_{18} + \mathbf{s}_{18};$   
 % Compute global coordinates of points R  
 %  $\mathbf{r}_{19} = \mathbf{r}_{19} + \mathbf{s}_{19};$   
 % Compute global coordinates of points S  
 %  $\mathbf{r}_{20} = \mathbf{r}_{20} + \mathbf{s}_{20};$   
 % Compute global coordinates of points T  
 %  $\mathbf{r}_{21} = \mathbf{r}_{21} + \mathbf{s}_{21};$   
 % Compute global coordinates of points U  
 %  $\mathbf{r}_{22} = \mathbf{r}_{22} + \mathbf{s}_{22};$   
 % Compute global coordinates of points V  
 %  $\mathbf{r}_{23} = \mathbf{r}_{23} + \mathbf{s}_{23};$   
 % Compute global coordinates of points W  
 %  $\mathbf{r}_{24} = \mathbf{r}_{24} + \mathbf{s}_{24};$   
 % Compute global coordinates of points X  
 %  $\mathbf{r}_{25} = \mathbf{r}_{25} + \mathbf{s}_{25};$   
 % Compute global coordinates of points Y  
 %  $\mathbf{r}_{26} = \mathbf{r}_{26} + \mathbf{s}_{26};$   
 % Compute global coordinates of points Z  
 %  $\mathbf{r}_{27} = \mathbf{r}_{27} + \mathbf{s}_{27};$   
 % Compute global coordinates of points AA  
 %  $\mathbf{r}_{28} = \mathbf{r}_{28} + \mathbf{s}_{28};$   
 % Compute global coordinates of points AB  
 %  $\mathbf{r}_{29} = \mathbf{r}_{29} + \mathbf{s}_{29};$   
 % Compute global coordinates of points AC  
 %  $\mathbf{r}_{30} = \mathbf{r}_{30} + \mathbf{s}_{30};$   
 % Compute global coordinates of points AD  
 %  $\mathbf{r}_{31} = \mathbf{r}_{31} + \mathbf{s}_{31};$   
 % Compute global coordinates of points AE  
 %  $\mathbf{r}_{32} = \mathbf{r}_{32} + \mathbf{s}_{32};$   
 % Compute global coordinates of points AF  
 %  $\mathbf{r}_{33} = \mathbf{r}_{33} + \mathbf{s}_{33};$   
 % Compute global coordinates of points AG  
 %  $\mathbf{r}_{34} = \mathbf{r}_{34} + \mathbf{s}_{34};$   
 % Compute global coordinates of points AH  
 %  $\mathbf{r}_{35} = \mathbf{r}_{35} + \mathbf{s}_{35};$   
 % Compute global coordinates of points AI  
 %  $\mathbf{r}_{36} = \mathbf{r}_{36} + \mathbf{s}_{36};$   
 % Compute global coordinates of points AJ  
 %  $\mathbf{r}_{37} = \mathbf{r}_{37} + \mathbf{s}_{37};$   
 % Compute global coordinates of points AK  
 %  $\mathbf{r}_{38} = \mathbf{r}_{38} + \mathbf{s}_{38};$   
 % Compute global coordinates of points AL  
 %  $\mathbf{r}_{39} = \mathbf{r}_{39} + \mathbf{s}_{39};$   
 % Compute global coordinates of points AM  
 %  $\mathbf{r}_{40} = \mathbf{r}_{40} + \mathbf{s}_{40};$   
 % Compute global coordinates of points AN  
 %  $\mathbf{r}_{41} = \mathbf{r}_{41} + \mathbf{s}_{41};$   
 % Compute global coordinates of points AO  
 %  $\mathbf{r}_{42} = \mathbf{r}_{42} + \mathbf{s}_{42};$   
 % Compute global coordinates of points AP  
 %  $\mathbf{r}_{43} = \mathbf{r}_{43} + \mathbf{s}_{43};$   
 % Compute global coordinates of points AQ  
 %  $\mathbf{r}_{44} = \mathbf{r}_{44} + \mathbf{s}_{44};$   
 % Compute global coordinates of points AR  
 %  $\mathbf{r}_{45} = \mathbf{r}_{45} + \mathbf{s}_{45};$   
 % Compute global coordinates of points AS  
 %  $\mathbf{r}_{46} = \mathbf{r}_{46} + \mathbf{s}_{46};$   
 % Compute global coordinates of points AT  
 %  $\mathbf{r}_{47} = \mathbf{r}_{47} + \mathbf{s}_{47};$   
 % Compute global coordinates of points AU  
 %  $\mathbf{r}_{48} = \mathbf{r}_{48} + \mathbf{s}_{48};$   
 % Compute global coordinates of points AV  
 %  $\mathbf{r}_{49} = \mathbf{r}_{49} + \mathbf{s}_{49};$   
 % Compute global coordinates of points AW  
 %  $\mathbf{r}_{50} = \mathbf{r}_{50} + \mathbf{s}_{50};$   
 % Compute global coordinates of points AX  
 %  $\mathbf{r}_{51} = \mathbf{r}_{51} + \mathbf{s}_{51};$   
 % Compute global coordinates of points AY  
 %  $\mathbf{r}_{52} = \mathbf{r}_{52} + \mathbf{s}_{52};$   
 % Compute global coordinates of points AZ  
 %  $\mathbf{r}_{53} = \mathbf{r}_{53} + \mathbf{s}_{53};$   
 % Compute global coordinates of points BA  
 %  $\mathbf{r}_{54} = \mathbf{r}_{54} + \mathbf{s}_{54};$   
 % Compute global coordinates of points BB  
 %  $\mathbf{r}_{55} = \mathbf{r}_{55} + \mathbf{s}_{55};$   
 % Compute global coordinates of points BC  
 %  $\mathbf{r}_{56} = \mathbf{r}_{56} + \mathbf{s}_{56};$   
 % Compute global coordinates of points BD  
 %  $\mathbf{r}_{57} = \mathbf{r}_{57} + \mathbf{s}_{57};$   
 % Compute global coordinates of points BE  
 %  $\mathbf{r}_{58} = \mathbf{r}_{58} + \mathbf{s}_{58};$   
 % Compute global coordinates of points BF  
 %  $\mathbf{r}_{59} = \mathbf{r}_{59} + \mathbf{s}_{59};$   
 % Compute global coordinates of points BG  
 %  $\mathbf{r}_{60} = \mathbf{r}_{60} + \mathbf{s}_{60};$   
 % Compute global coordinates of points BH  
 %  $\mathbf{r}_{61} = \mathbf{r}_{61} + \mathbf{s}_{61};$   
 % Compute global coordinates of points BI  
 %  $\mathbf{r}_{62} = \mathbf{r}_{62} + \mathbf{s}_{62};$   
 % Compute global coordinates of points BJ  
 %  $\mathbf{r}_{63} = \mathbf{r}_{63} + \mathbf{s}_{63};$   
 % Compute global coordinates of points BK  
 %  $\mathbf{r}_{64} = \mathbf{r}_{64} + \mathbf{s}_{64};$   
 % Compute global coordinates of points BL  
 %  $\mathbf{r}_{65} = \mathbf{r}_{65} + \mathbf{s}_{65};$   
 % Compute global coordinates of points BM  
 %  $\mathbf{r}_{66} = \mathbf{r}_{66} + \mathbf{s}_{66};$   
 % Compute global coordinates of points BN  
 %  $\mathbf{r}_{67} = \mathbf{r}_{67} + \mathbf{s}_{67};$   
 % Compute global coordinates of points BO  
 %  $\mathbf{r}_{68} = \mathbf{r}_{68} + \mathbf{s}_{68};$   
 % Compute global coordinates of points BP  
 %  $\mathbf{r}_{69} = \mathbf{r}_{69} + \mathbf{s}_{69};$   
 % Compute global coordinates of points BQ  
 %  $\mathbf{r}_{70} = \mathbf{r}_{70} + \mathbf{s}_{70};$   
 % Compute global coordinates of points BR  
 %  $\mathbf{r}_{71} = \mathbf{r}_{71} + \mathbf{s}_{71};$   
 % Compute global coordinates of points BS  
 %  $\mathbf{r}_{72} = \mathbf{r}_{72} + \mathbf{s}_{72};$   
 % Compute global coordinates of points BT  
 %  $\mathbf{r}_{73} = \mathbf{r}_{73} + \mathbf{s}_{73};$   
 % Compute global coordinates of points BU  
 %  $\mathbf{r}_{74} = \mathbf{r}_{74} + \mathbf{s}_{74};$

The diagram illustrates a 3DOF system. A horizontal bar is supported by three vertical springs. A dashed line indicates the displacement of the bar, and a dashed circle highlights the displacement of the first spring.

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# Planar Multibody Dynamics Solution Manual

**Werner Schiehlen**



## **Planar Multibody Dynamics Solution Manual:**

**Planar Multibody Dynamics** Parviz E. Nikravesh, 2008 Written by Parviz Nikravesh one of the world's best known experts in multibody dynamics *Planar Multibody Dynamics Formulation Programming and Applications* enhances the quality and ease of design education with extensive use of the latest computerized design tools combined with coverage of classical design and dynamics of machinery principles Using language that is clear concise and to the point the textbook introduces fundamental theories computational methods and program development for analyzing simple to complex planar mechanical systems The author chose MATLAB as the programming language and since students may not be skilled programmers the examples and exercises provide a tutorial for learning MATLAB The examples begin with basic commands before introducing students to more advanced programming techniques The routines developed in each chapter eventually come together to form complete programs for different types of analysis Pedagogical highlights Contains homework problems at the end of each chapter some requiring standard pencil and paper solution in order to understand the concept and others requiring either programming or the use of existing programs Electronic highlights All the programs that are listed in the book and some additional programs will be available for download and will be updated periodically by the author Additional materials for instructors such as a solutions manual and other teaching aids will also be available on the website The author organizes the analytical and computational subjects around practical application examples He uses several examples repeatedly in various chapters providing students with a basis for comparison between different formulations The final chapter describes more extensive modeling and simulation projects Designed specifically for undergraduates the book is suitable as a primary text for a course on mechanisms or a supplementary text for a course on dynamics

*Planar Multibody Dynamics* Parviz Nikravesh, 2018-09-03 *Planar Multibody Dynamics Formulation Programming with MATLAB and Applications* Second Edition provides sets of methodologies for analyzing the dynamics of mechanical systems such as mechanisms and machineries with coverage of both classical and modern principles Using clear and concise language the text introduces fundamental theories computational methods and program development for analyzing simple to complex systems MATLAB is used throughout with examples beginning with basic commands before introducing students to more advanced programming techniques The simple programs developed in each chapter come together to form complete programs for different types of analysis Features Two new chapters on free body diagram and vector loop concepts demonstrate that the modern computational techniques of formulating the equations of motion is merely an organized and systematic interpretation of the classical methods A new chapter on modeling impact between rigid bodies is based on two concepts known as continuous and piecewise methods A thorough discussion on modeling friction and the associated computational issues The short MATLAB programs that are listed in the book can be downloaded from a companion website Several other MATLAB programs and their user manuals can be downloaded from the companion website including a general purpose program for kinematic

inverse dynamic and forward dynamic analysis a semi general purpose program that allows student to experiment with his or her own formulation of equations of motion a special purpose program for kinematic and inverse dynamic analysis of four bar mechanisms The preceding three sets of programs contain animation capabilities for easy visualization of the simulated motion A greater range of examples problems and projects

**Virtual Nonlinear Multibody Systems** Werner

Schiehlen, Michael Valásek, 2012-12-06 This book contains an edited version of lectures presented at the NATO ADVANCED STUDY INSTITUTE on VIRTUAL NONLINEAR MULTIBODY SYSTEMS which was held in Prague Czech Republic from 23 June to 3 July 2002 It was organized by the Department of Mechanics Faculty of Mechanical Engineering Czech Technical University in Prague in cooperation with the Institute B of Mechanics University of Stuttgart Germany The ADVANCED STUDY INSTITUTE addressed the state of the art in multibody dynamics placing special emphasis on nonlinear systems virtual reality and control design as required in mechatronics and its corresponding applications Eighty six participants from twenty two countries representing academia industry government and research institutions attended the meeting The high qualification of the participants contributed greatly to the success of the ADVANCED STUDY INSTITUTE in that it promoted the exchange of experience between leading scientists and young scholars and encouraged discussions to generate new ideas and to define directions of research and future developments The full program of the ADVANCED STUDY INSTITUTE included also contributed presentations made by participants where different topics were explored among them Such topics include nonholonomic systems flexible multibody systems contact impact and collision numerical methods of differential algebraic equations simulation approaches virtual modelling mechatronic design control biomechanics space structures and vehicle dynamics These presentations have been reviewed and a selection will be published in this volume and in special issues of the journals Multibody System Dynamics and Mechanics of Structures and Machines

**Kinematics and**

**Dynamics of Multibody Systems with Imperfect Joints** Paulo Flores, Jorge Ambrósio, J.C. Pimenta Claro, Hamid M.

Lankarani, 2008-01-10 This book presents suitable methodologies for the dynamic analysis of multibody mechanical systems with joints It contains studies and case studies of real and imperfect joints The book is intended for researchers engineers and graduate students in applied and computational mechanics

**Solution Manual for Mechanics and Control of**

**Robots** Krishna C. Gupta, 1997-04-24 Intended as an introduction to robot mechanics for students of mechanical industrial electrical and bio mechanical engineering this graduate text presents a wide range of approaches and topics It avoids formalism and proofs but nonetheless discusses advanced concepts and contemporary applications It will thus also be of interest to practicing engineers The book begins with kinematics emphasizing an approach based on rigid body displacements instead of coordinate transformations it then turns to inverse kinematic analysis presenting the widely used Pieper Roth and zero reference position methods This is followed by a discussion of workplace characterization and determination One focus of the discussion is the motion made possible by spherical and other novel wrist designs The text

concludes with a brief discussion of dynamics and control An extensive bibliography provides access to the current literature

**Advanced Multibody System Dynamics** Werner Schiehlen, 2013-04-17 The German Research Council DFG decided 1987 to establish a nationwide five year research project devoted to dynamics of multibody systems In this project universities and research centers cooperated with the goal to develop a general purpose multibody system software package This concept provides the opportunity to use a modular structure of the software i e different multibody formalisms may be combined with different simulation programmes via standardized interfaces For the DFG project the database RSYST was chosen using standard FORTRAN 77 and an object oriented multibody system datamodel was defined The project included research on the fundamentals of the method of multibody systems concepts for new formalisms of dynamical analysis development of efficient numerical algorithms and realization of a powerful software package of multibody systems These goals required an interdisciplinary cooperation between mathematics computer science mechanics and control theory ix X After a rigorous reviewing process the following research institutions participated in the project under the responsibility of leading scientists Technical University of Aachen Prof G Sedlacek Technical University of Darmstadt Prof P Hagedorn University of Duisburg M Hiller Prof *Applied Mechanics Reviews* ,1988 *Intermediate Dynamics* Edward J. Haug, 1992

**Romansy 14** Giovanni Bianchi, Jean-Claude Guinot, Cezary Rzymkowski, 2014-05-04 Mechanics Motion Control Sensing and Programming Synthesis and Design Legged Locomotion and Biomechanical Aspects of Robots and Manipulators world view of the state of the art Characterization This volume presents the latest contribution to the theory and practice of modern robotics given by the world recognized scientists from Australia Canada Europe Japan Mexico Singapore and USA

*Mechanism Design* Kevin Russell, Qiong "John" Shen, Raj S. Sodhi, 2025-11-04 This updated edition of Mechanism Design Visual and Programmable Approaches using MATLAB and Simscape Multibody™ offers a comprehensive introduction to kinematic synthesis covering motion path and function generation techniques for a wide range of planar and spatial single and multi loop linkage systems This book presents foundational concepts alongside practical methodologies making it an accessible resource for both students and practitioners in the field In this revised edition real world application of the presented methods is supported through the integration of MATLAB and its powerful simulation and visualization toolbox Simscape Multibody™ These tools help bridge theory and practice allowing readers to implement kinematic synthesis techniques and observe system behavior through dynamic visualizations New content expands this book's scope including topics such as geared five bar kinematic synthesis and both forward and inverse kinematics for robotic systems Designed as a complete introduction to kinematic synthesis this book is an essential resource for students in mechanical engineering and related disciplines seeking to master the principles and practicalities of mechanism design The new edition also includes a solution manual and MATLAB as an online resource for instructors to support the topics discussed in this book **XXI**

**Congreso Nacional de Ingeniería Mecánica** Emilio Velasco Sánchez, Miguel Sánchez Lozano, Ramón Peral

Orts,2016-11-09 Congreso Nacional de Ingeniería Mecánica se realiza bianualmente promovido por la Asociación Española de Ingeniería Mecánica AEIM En su XXI edición este Congreso está organizado por el Grupo de Ingeniería Mecánica Aplicada AME del Departamento de Ingeniería Mecánica y Energía de la Universidad Miguel Hernández Y se ha celebrado en la ciudad de Elche Alicante España El Congreso Nacional de Ingeniería Mecánica es el principal lugar de encuentro para el intercambio de conocimiento científico y técnico de experiencias profesionales y de proyectos competitivos en el campo de la Ingeniería Mecánica a nivel nacional Los artículos presentados se organizan en 18 áreas temáticas El libro está organizado por tanto en capítulos por áreas temáticas Se han presentado 224 comunicaciones científicas de gran nivel que muestran el buen hacer de los investigadores en Ingeniería Mecánica

**Scientific and Technical Aerospace Reports** ,1995 **Large Space Structures & Systems in the Space Station Era** ,1992 **Control Design and Analysis for Underactuated Robotic Systems** Xin Xin,Yannian Liu,2014-01-03

The last two decades have witnessed considerable progress in the study of underactuated robotic systems URSs Control Design and Analysis for Underactuated Robotic Systems presents a unified treatment of control design and analysis for a class of URSs which include systems with multiple degree of freedom and or with underactuation degree two It presents novel notions features design techniques and strictly global motion analysis results for these systems These new materials are shown to be vital in studying the control design and stability analysis of URSs Control Design and Analysis for Underactuated Robotic Systems includes the modelling control design and analysis presented in a systematic way particularly for the following examples 1 directly and remotely driven Acrobots 1 Pendubot 1 rotational pendulum 1 counter weighted Acrobot 2 link underactuated robot with flexible elbow joint 1 variable length pendulum 1 3 link gymnastic robot with passive first joint 1 n link planar robot with passive first joint 1 n link planar robot with passive single joint double or two parallel pendulums on a cart 1 3 link planar robots with underactuation degree two 2 link free flying robot The theoretical developments are validated by experimental results for the remotely driven Acrobot and the rotational pendulum Control Design and Analysis for Underactuated Robotic Systems is intended for advanced undergraduate and graduate students and researchers in the area of control systems mechanical and robotics systems nonlinear systems and oscillation This text will not only enable the reader to gain a better understanding of the power and fundamental limitations of linear and nonlinear control theory for the control design and analysis for these URSs but also inspire the reader to address the challenges of more complex URSs

**Integrated Product and Process Development** John M. Usher,Utpal Roy,Hamid Parsaei,1998-03-13 The phenomenal success of integrated product and process development IPPD at such companies as Boeing Motorola and Hewlett Packard has led many manufacturers to place renewed emphasis on this critical aspect of concurrent engineering If you are among those charged with the daunting task of implementing upgrading or maintaining IPPD you need a single reference handbook that covers all of the tools technologies and applications that support IPPD You need Integrated Product and Process Development Emphasizing applications this extremely user friendly

guide covers everything from basic principles to cutting edge research It addresses ideas and methods in product design as well as issues related to process design and manufacturing Case studies illustrate the application of various tools and techniques of IPPD in manufacturing for the defense industry making the most of product planning applications of quality function deployment QFD the effective use of design optimization and integrating design and process planning Other topics covered include Identifying customer needs using QFD Issues and constraints in time driven product development Enhancing automated design systems with functional design Rapid prototyping Case based process planning systems     *Advances in Mechanism and Machine Science* Tadeusz Uhl,2019-06-13 This book gathers the proceedings of the 15th IFToMM World Congress which was held in Krakow Poland from June 30 to July 4 2019 Having been organized every four years since 1965 the Congress represents the world s largest scientific event on mechanism and machine science MMS The contributions cover an extremely diverse range of topics including biomechanical engineering computational kinematics design methodologies dynamics of machinery multibody dynamics gearing and transmissions history of MMS linkage and mechanical controls robotics and mechatronics micro mechanisms reliability of machines and mechanisms rotor dynamics standardization of terminology sustainable energy systems transportation machinery tribology and vibration Selected by means of a rigorous international peer review process they highlight numerous exciting advances and ideas that will spur novel research directions and foster new multidisciplinary collaborations     *Traditional and Innovative Approaches in Seismic Design* Linda Giresini,Francesca Taddei,2018-03-19 This book is a printed edition of the Special Issue Traditional and Innovative Approaches in Seismic Design that was published in Buildings     *NASA SP. ,1992     **International Aerospace Abstracts** ,1998     Large Space Structures & Systems in the Space Station Era ,1993*

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