Delft University of Technology
Faculty of Mechanical Engineering
Laboratory for Engineering Mechanics
Mekelweg 2, Delft
The Netherlands

Exam

Multibody Dynamics A
wb1310

Course 2005/2006

June 20, 2006, 14-17 h

Questionnaire & Answer Form.

Terms:

- Use the boxed space on this form to formulate your answer.
- Clearly state your name and student id number on every form.
- Motivate your answers; only numbers and formulas is note sufficient!
- After the exam you have to hand in this form plus your report on the practical assignments.
- Clearly state the name and student id number of *both* you and your co-author on the practical report.
- This is an open book exam, you are free to consult your lecture notes, books etc.
- The exam is individual; you may NOT consult with your colleagues.

Name: _____

Student id number: | | | | | | | |

Name: Student id number: | | | | | | | |

Question 1-1
Sketch the model from Assignment 1-2 and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom.

Answer:
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2 pts.

Question 1-2
If we continue the simulation from Assignment 1-2 for a somewhat longer time, say a hundred times the period of natural vibration, you will notice that the amplitude of oscillation will either increase or decrease. Is this correct? Why does this happen?

Answer:
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4 pts.

Question 1-3
The period T of the natural oscillatory motion will increase if we increase the initial angular displacement ϕ_0 according to $T= T_0 (1+\phi_0^2/16)$, with ϕ_0 in [rad]. Calculate this period T and compare this with the result from your ADAMS simulation as in Assignment 1-2 and 1-4. Discuss the results.

Answer:

ϕ_0	T [sec]	T_{ADAMS} [sec]	$(T-T_{ADAMS})/T$
30^0			
60^0			

Discussion:
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4 pts.

Name: Student id number: | | | | | | | |

Question 2-1

Sketch the model from Assignment 2-2 and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom.

Answer:

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4 pts.

Question 2-2

Draw the components $\left(\omega_x, \omega_y, \omega_z\right)$ of the angular velocity ω of the wheel expressed in the global fixed reference frame *O-xyz* as a function of time for the period of $t = 0..12$ [sec], where *z* is up and *x* is pointing in the initially forward direction.

Answer:

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6 pts.

Name: Student id number: | | | | | | | |

Question 3-1

Sketch the model from Assignment 3-2 and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom.

Answer:

2 pts.

Question 3-2

We replace the 4 stiff cables by 4 distance constraints. Sketch this model and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom.
Describe the possible motions of the container. Why does this *not* agree with the number of degrees of freedom?

Answer:

8 pts.

Name: Student id number: | | | | | | | |

Question 4-1

Sketch the model from Assignment 4-3 and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom.

Answer:

3 pts.

Question 4-2

The objective of the regulator is to maintain a constant speed ω despite any disturbance. Looking at the results this is not the case. Draw a block diagram of the controlled system, and clearly identify the plant (engine), the controller (regulator), and the signals for the speed, the speed set point, the engine torque, and the torque disturbance. Calculate the offset in the collar height h for engine type C=7500 N. Compare this with the result from your simulation.

Answer:

7 pts.

Name: Student id number: | | | | | | | |

Question 5-1

Sketch the model from Assignment 5-1 and identify: the number of rigid bodies, the number and type of constraints, the number of prescribed motions and the number of degrees of freedom. Keep in mind that the tire model consists of 1 rigid body, the wheel, plus 1 revolute joint which makes the connection between the wheel and the chassis. The interaction between the wheel and the ground is solemnly achieved by the non-linear tire forces, and is therefore not constraint.

Answer:

4 pts.

Question 5-2

In order to maintain a constant speed along the track in the flat xy-plane we add cruise control by means of first order system. Derive the expressions for the forces acting on the cm of the tractor given the current speed v along the track, the track angle α with the x-axis, the mass of the tractor m, and a constant C. Make a realistic estimate for C.

Answer:

6 pts.