

# MSS Quick Reference

mssSimulink.slx

Simulink Library

## Simulink demos

demoWaypointGuidance.slx

waypoint guidance system

demoWaveElevation.slx

computation of wave elevation from wave spectra

demoSemisubDPsystem.slx

semisubmersible DP system

demoS175WindCurrentAutopilot.slx

S175 heading autopilot with wind and current loads

demoPassiveWavefilterAutopilot1.slx

passive wave filter and heading autopilot design using compass measurements only

demoPassiveWavefilterAutopilot2.slx

passive wave filter and heading autopilot design using compass and yaw rate measurements

demoPanamaxContainerShip.slx

panama container ship simulator

demoNavalVesselMano.slx

zigzag test for the naval ship Mano

demoKalmanWavefilterAutopilot.slx

Kalman-filter based wave filter and heading autopilot for the mariner class cargo ship

demoDSRVdepthControl.slx

depth control of DSRV

demoDPThrusterModels.slx

supply vessel with azimuth thrusters

demoCS2passiveObserverDP.slx

passive observer design with wave filtering and nonlinear PID control of the CyberShip2 model ship

## Vessel models (m-files)

clarke83

linear maneuvering model parametrized using (L,B,T) found from linear regression of model tests (Clarke et al. 1983)

container

nonlinear maneuvering model of a high-speed container ship, L = 175 m, including the roll mode (Son and Nomoto 1982)

DSRV

deep submergence rescue vehicle (DSRV), L = 5.0 m (Healey 1992)

frigate

nonlinear autopilot model for a frigate, L = 100 m

Lcontainer

linearized model of a high-speed container ship, L = 175 m, including the roll mode (Son and Nomoto 1982)

mariner

nonlinear maneuvering model for the Mariner class vessel, L = 160 m

navalvessel

nonlinear maneuvering model of a multipurpose naval vessel, L = 51.5 m

npsauv

Naval Postgraduate School autonomous underwater vehicle (AUV), L = 5.3 m

otter

small autonomous USV, L = 2.0 m

rig

semisubmersible linear mass-damper-spring model, L = 84.6 m

ROVzefakkel

nonlinear autopilot model of a boat, L = 45 m

|        |  |
|--------|--|
| supply | linear DP model of a supply vessel, $L = 76.2$ m                     |
| tanker | nonlinear course unstable maneuvering model of a tanker, $L = 304$ m |

### **Vessel time-series simulation (m-files)**

|                |  |
|----------------|--|
| SIMclarke83    | simulate clarke83.m under PD control                       |
| SIMmariner     | simulate mariner.m under PD control                        |
| SIMcontainer   | simulate container.m and Lcontainer.m under PD control     |
| SIMnavalvessel | simulate navalvessel.m under PD control                    |
| SIMrig         | simulate the 6-DOF semisubmersible model under PID control |

### **Modelling (m-files)**

|            |  |
|------------|--|
| Gmtrx      | 6x6 system spring stiffness matrix $G$   |
| gvect      | 6x1 vector of restoring forces   |
| m2c        | 6x6 Coriolis-centripetal matrix $C(nu)$ from system inertia matrix $M$                 |
| rbody      | 6x6 rigid-body system inertia and Coriolis-centripetal matrix matrices $MRB$ and $CRB$ |
| wageningen | thrust and torque coefficients of the Wageningen B-series propellers                   |

### **Kinematics (m-files)**

|          |  |
|----------|--|
| ecef2llh | longitude, latitude and height from ECEF positions $x$ , $y$ and $z$           |
| euler2q  | unit quaternion from Euler angles  |
| eulerang | computes the Euler angle transformation matrix $J$                             |
| flat2llh | longitude, latitude and height from flat-earth positions $x$ , $y$ and $z$     |
| llh2ecef | ECEF positions $x$ , $y$ and $z$ from longitude, latitude and height           |
| llh2flat | flat-earth positions $x$ , $y$ and $z$ from longitude, latitude and height     |
| R2euler  | Euler angles from rotation matrix elements                                     |
| Rll      | Euler angle rotation matrix $Rll$ for longitude and latitude                   |
| Rquat    | unit quaternion rotation matrix $R$ in $SO(3)$                                 |
| Rzyx     | Euler angle rotation matrix $R$ in $SO(3)$                                     |
| Tquat    | unit quaternion transformation matrix $T$ , representing the attitude dynamics |
| Tzyx     | Euler angle transformation matrix $T$ , representing the attitude dynamics     |

|           |   |
|-----------|---|
| q2euler   | Euler angles from a unit quaternion   |
| quatern   | unit quaternion transformation matrix J   |
| quatprod  | quaternion product  |
| quest     | quaternion rotation matrix $R(q)$ and unit quaternion $q$ between two vectors $W = R(q) V$                |
| quest6dof | 6-DOF vector $\eta = [x, y, z, \phi, \theta, \psi]$ from three marker positions using the QUEST algorithm |

### Transformations (m-files)

|            |  |
|------------|--|
| conversion | defines global conversion factors for GNC applications                                     |
| rad2pipi   | obsolete, use ssa  |
| ssa        | smallest signed angle, maps an angle in rad to the interval $[-\pi, \pi]$ or $[-180, 180]$ |
| Smtrx      | 3x3 vector skew-symmetric matrix S   |
| Hmtrx      | 6x6 system transformation matrix H   |
| vex        | computes $a = \text{vex}(S(a))$ where S is a skew-symmetric matrix                         |

### Environment (m-files)

|                 |   |
|-----------------|---|
| blendermann94   | computes the wind forces and wind coefficients using Blendermann (1994)                   |
| encounter       | encounter frequency as a function of wave peak frequency, vessel speed and wave direction |
| hs2vw           | converts significant wave height into an equivalent wind speed                            |
| isherwood72     | computes the wind forces and coefficients based on Isherwood (1972)                       |
| rand_phases     | generates a uniformly distributed vector of random phases in the interval $[-\pi, \pi]$   |
| vw2hs           | converts average wind speed to significant wave height                                    |
| waveresponse345 | steady-state heave, roll and pitch responses for a ship in regular waves                  |
| wavespec        | function used to evaluate different type of wave spectra                                  |
| ww2we           | function used to transform a vector of wave frequencies to encounter frequencies          |

### Ship maneuvers (m-files)

|            |                       |
|------------|-----------------------|
| pullout    | ship pullout maneuver |
| turncircle | ship turning circle   |
| zigzag     | ship zigzag maneuver  |

### **Motion sickness (m-files)**

|        |  |
|--------|--|
| ISOmsi | ISO 2631-3, 1997 motion sickness incidence             |
| HMmsi  | O'Hanlon and McCauley (1974) motion sickness incidence |

### **Hydrodynamics (m-files)**

|              |  |
|--------------|--|
| DPperiods    | Periods and natural frequencies of a marine craft in DP  |
| Hoerner      | 2D Hoerner crossflow form coefficient as a function of B and T   |
| loadcond     | plots the roll and pitch periods as a function of GM_T and GM_L  |
| plotABC      | plots the hydrodynamic coefficients Aij, Bij and Cij as a function of frequency                                    |
| plotBv       | plots viscous damping Bvii as a function of frequency  |
| plotTF       | plots the motion or force RAO transfer functions   |
| plotWD       | plots the wave drift amplitudes  |
| veres2vessel | reads data from ShipX output files and store the data as a mat-file containing the structure <vessel>              |
| vessel2ss    | computes the fluid-memory transfer functions and store the data as a mat-file containing the structure <vesselABC> |
| wamit2vessel | reads data from WAMIT output files and store the data as a mat-file containing the structure <vessel>              |

### **Hydrodynamic templates (Simulink)**

|                  |  |
|------------------|--|
| DP_ForceRAO.slx  | Simulink template for a DP vessel where wave loads are computed using force RAOs                   |
| DP_MotionRAO.slx | Simulink template for a DP vessel where wave loads are computed using motion RAOs                  |
| MAN_ForceRAO.slx | Simulink template for the unified maneuvering model where wave loads are computed using force RAOs |

### **Guidance (m-files)**

|               |   |
|---------------|---|
| crosstrack    | computes the path-tangential origin and cross-track error for a target                |
| crosstrackWpt | computes the cross-track error when the path is a straight line between two waypoints |
| hybridPath    | generates coefficients for subpaths between waypoints                                 |
| order3        | path generation using cubic polynomials (see demoWaypointGuidance.slx)                |
| order5        | path generation using 5th-order polynomials (see demoWaypointGuidance.slx)            |

### Navigation (m-files)

|               |   |
|---------------|---|
| acc2rollpitch | static roll and pitch angles from specific force  |
| gravity       | acceleration of gravity as a function of latitude using the WGS-84 ellipsoid parameters |
| ins_ahrs      | Error-state Kalman filter for INS aided by position and AHRS measurements               |
| ins_euler     | Error-state Kalman filter for INS aided by position and yaw angle measurements          |
| ins_mekf      | Error-state Kalman filter for INS aided by position and magnetic field measurements     |
| ins_mekf_psi  | Error-state Kalman filter for INS aided by position and yaw angle measurements          |
| insSignal     | basic INS signal generator  |

### Control (m-files)

|           |   |
|-----------|---|
| lqtracker | computes the LQ tracker gain matrices for LTI systems         |
| nomoto    | generates Bode plots for the 1st- and 2nd-order Nomoto models |
| ucalloc   | unconstrained control allocation                              |

### Numerical integration methods (m-files)

|        |   |
|--------|---|
| euler2 | integrates a system of ordinary differential equations using Euler's 2nd-order method       |
| rk4    | integrates a system of ordinary differential equations using Runge-Kutta's 4th-order method |