

SEMESTER VI

OE3036: MANOEUVRING AND CONTROL OF MARINE VEHICLES

Course Content:

Controllability fundamentals of ships and submarines–Introduction- Kinematics of rotating frame, Nonlinear 6-DoF and 3-DoF rigid body equation of motion, nonlinear and linear hydrodynamic derivatives, linear equations of motion for ship, longitudinal and lateral models for submarines, stability indices; Stability and control in the horizontal and vertical planes; Munk moment Definitive manoeuvres – turning tests, overshoot and zigzag tests, spiral and pullout tests, accelerating, stopping and backing tests. Control surface hydrodynamics – rudder geometry, aspect ratio, influence of fixed structures; Control surface design - specification of requirements and constraints on rudder design, types of rudder, rudder stock; Influence of ship features on controls fixed stability. Experimental determination of hydrodynamic derivatives - straight line test, rotating arm technique, planar motion mechanism; Numerical methods used in ship manoeuvring problems, ship manoeuvring simulators; IMO Rules and Recommendations. Ship manoeuvring sea trials. Control fundamentals-introduction-(Linear and nonlinear control, PID) , Linear system representation, first and second order Nomoto Equation, State-space modelling, Converting State-space model to transfer function, PD & PID controllers, Tuning, PID controller with acceleration feedback Practicals : 1. Calculation of free stream characteristics of rudder. 2. Rudder design – dimensions, form, structure and system Experiments: 1. Straight line test in towing tank 2. PMM tests in the towing tank 3. Free running models tests in the basin

Text Books:

1. **Lewis, E.U**, Principles of Naval Architecture, SNAME, New Jersey, U.S.A, 2010.
2. **Fossen, T.I**, Guidance and Control of Marine Vehicles, John Wiley & Sons, 1999
3. **Molland, A.F and Turnock, S.R.**, Marine Rudders and Control Surfaces, Elsevier, 2007
4. **Lewandowski, E.M.** The Dynamics of Marine Crafts – Seakeeping & Maneuvering, World Scientific, 2004

Reference Books:

1. **Abkowitz, M.A.**; Lectures on Ship Hydrodynamics – Steering and Manoeuvrability, Danish Technical Press, Copenhagen, Denmark, 1964
2. Lecture notes – Maneuvering and control of marine vehicles, **Michael S. Triantafyllou, Franz S. Hover** , Department of Ocean Engineering Massachusetts Institute of Technology Cambridge, Massachusetts USA
3. **Khac Duc Do and Jie Pan**, Control of Ships and Underwater Vehicles , Springer, 2009
4. **Faltinsen, M.O.** Hydrodynamics of High Speed Marine Vehicles, Cambridge University Press, 2009
5. **Newman J.N**; ‘Marine Hydrodynamics’, MIT Press, USA, 1977

Prerequisite: