Course Brochure

Name of course	**Non-linear problems in Hydroelasticity**
Course level	**PG**
Duration	**13-17, December, 2021**
Discipline	**Ocean Engineering and Naval Architecture**
Mode of lecture	**Online mode**
Lecture hours	**12**
Pre-requisites	**Classical Hydrodynamics, Potential Flows**
Targetted Audience	**Young faculty, RS and PG students specializing in Water Waves with Applied Mathematics or Ocean Engineering background**

Course Description

In a one-week intensive the topical non-linear problems on wave-wave and wave-current interactions will be presented. This course contains 12 hours of lectures which will be equivalent to a two-credit course for post-graduate students at the IIT Kharagpur. Emphasis will be given to various physical problems arising in Ocean Engineering and Arctic Engineering. The course will be focused on the role of non-linearity in hydrodynamics and elasticity. In the context of hydroelasticity, it will be a highlight of the transition from linear to non-linear effects. Various non-linear problems of hydroelastlcity will be introduced and demonstrated through specific problems and various techniques to solve hydroelasticity problems will be discussed.

Course Contents *(# of lecture hours)*

Topic/Lecture	Contents	# of hours
Non-linearity in hydrodynamics and hydroelasticity		**8**
Lecture 1 (T. Sahoo)	Recent trends on blocking of flexural gravity waves	**1**
Lecture 2 (Y. Stepanyants)	Nonlinear waves in a rotating ocean	**1**
Lecture 3 (Y. Stepanyants)	Nonlinear waves in a rotating ocean	**1**
Lecture 4 (Y. Stepanyants)	The asymptotic approach to the description of two-dimensional symmetric soliton patterns	**1**
Lecture 5 (Y. Stepanyants)	The emergence of envelop solitary waves from initial localised pulses within the Ostrovsky equation	**1**
Lecture 6 (M. Meylan)	Nonlinear waves in infinite plates	**1**
Lecture 7 (M. Meylan)	Nonlinear effects of moving sources on ice plates	**1**
Lecture 8 (M. Meylan)	Nonlinear Waves in the Marginal Ice Zone	**1**
Hydroelasticity in Ocean Engineering		**4**
Lecture 1 (Y. Stepanyants)	Waves on a compressed floating ice plate caused by motion of a dipole in water	**1**
Lecture 2 (M. Meylan)	Overwash of flexible plates	**1**
Lecture 3 (M. Meylan)	Effect of Tsunami waves on Very Large Floating Structures	**1**
Lecture 4 (S. Das)	Introduction to water compressibility and its effect on hydroelastic wave	**1**

Reference:

- Books:

  1) Fabrikant A.L., Stepanyants Yu.A. Propagation of waves in shear flows. World Scientific, Singapore, 1998, 287 p.
  2) Lamb, Horace. *Hydrodynamics*. Cambridge university press, 1993.
  3)K. F. Graff, Wave Motion in elastic solids, Dover Publication, 1975

4.T. Sahoo, Mathematical techniques for wave interaction with flexible structures, CRC Press, 2012

- Articles:

1) Apel J., Ostrovsky L.A., Stepanyants Y.A., Lynch J.F. Internal solitons in the ocean and their effect on underwater sound. J. Acoust. Soc. Am., 2007, v. 121, n. 2, 695–722.
2) Ostrovsky L.A., Pelinovsky E.N., Shrira V.I. and Stepanyants Y.A. Beyond the KDV: Post-explosion development. Chaos, 2015, v. 25, n. 9, 097620.
3) Stepanyants Y.A. Nonlinear waves in a rotating ocean (the Ostrovsky equation, its generalisations and applications). Izvestiya, Atmospheric and Oceanic Physics, 2020, v. 56, n. 1, 16–32.
4) Stepanyants Y.A. The asymptotic approach to the description of two-dimensional symmetric soliton patterns. Symmetry, 2020, v. 12, 1586.
5) Grimshaw R., Stepanyants Y. Emergence of envelop solitary waves from initial localised pulses within the Ostrovsky equation. Radiophysics and Quantum Electronics, 2020, v. 63, n. 1, 21–28.
6) Stepanyants Y.A., Sturova I.V. Rossby waves in the ocean covered by compressed ice. Geophys. Astrophys. Fluid Dyn., 2020, v. 114, n. 3, 306–316.
7) Stepanyants Y.A., Sturova I.V. Waves on a compressed floating ice plate caused by motion of a dipole in water. J. Fluid Mech., 2021, v. 907, A7, 29 p.
8) Eyov, Erez, et al. Progressive waves in a compressible ocean with an elastic bottom. *Wave Motion*, 2013, v. 50, n. 5, 929-939.
9) Abdolali, Ali, et al. On the propagation of acoustic-gravity waves under elastic ice sheets. *J. Fluid Mech.*, 2018, v. 837, 640-656.
10) Nonlinear Higher-Order Spectral Solution for a Two-Dimensional Moving Load on Ice
F Bonnefoy, M. H. Meylan, P Ferrant, *J. Fluid Mech*. 2009, . 621, 215–242
11) Modelling water wave overwash of a thin floating plate, DM Skene, LG Bennetts, MH Meylan, A Toffoli. *J. Fluid Mech*. 777

- Book Chapters:

1) Gorshkov K.A., Ostrovsky L.A., Stepanyants Yu.A. Dynamics of soliton chains: From simple to complex and chaotic motions. In: Long-Range Interactions, Stochasticity and Fractional Dynamics, eds. Albert C.J. Luo and Valentin Afraimovich, Springer, 2010, 177–218.
2) Stepanyants Y. Multi-lump structures in the Kadomtsev–Petviashvili equation. In: Advances in Dynamics, Patterns, Cognition, eds. Aronson, I.S., Pikovsky, A., Rulkov, N.F., Tsimring, L.S., Springer, 2017, 307–324.

- Online materials:

Resource Personnel

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