Department of Ocean Engineering
IIT Madras

Orientation for Ph.D. / MS scholars

28<sup>th</sup> Dec 2016

- Choice of research topic & Guide selection criteria
- Responsibilities of the Scholars
- Benefits
- Faculties & their research interest
Choice of Research Topic & Guide

- You will CHOOSE the ‘research topic and guide’ according to your research interest
- We facilitate you to make a better choice
- You are free to choose other topics irrespective of indication in your application
- You may meet as many faculty members as possible for discussion to finalize your choice(s)
- Submit your first 3 choices to HoD preferably before 3 pm on 3 Jan 2017. If you opt for Project mode, choose it separately in concurrence with the Project Coordinator
- If you have given the ‘admission offer’ on the Project mode, you may contact us to find out the Coordinator, if not known already.

You NEED to submit the FORM with your THREE choices by 3 Jan 2017.
Responsibilities of MS/ PhD Scholars

• GTC (MS)/ DC (PhD) committee will monitor each scholar’s progress.
• PhD scholars have to complete comprehensive viva voce (CVV) examination, preferably within 18 months.
• HTRA assignments prescribed by the Department have to be fulfilled for the part of the scholarship.

Benefits

• Contingency grant
• Funding support to attend 1 National Conference every year
• Funding support from Institute to attend 1 International Conference
• Additional Funding can be sought from Alumni association/ DST/ CSIR/ INSA etc.

Scholars who show good progress (in terms of International Journal paper publications)
• Complimentary Membership in International bodies – RINA, PIANC, IAHR etc.
India imports 75% of oil consumed in the country, and we need to reduce dependency on fossil fuels (oil/gas/coal). We have 7500km (total) coastline. Ocean stores huge amount of energy and it is expected to harvest 10% of global energy need from wave energy only. Several technologies are available to harness such energy and there are challenges such as system efficiency, cost, affordability, reliability, sustainability, acceptability, etc. WEFEL has a mission to work on ‘Marine Energy’ for the people of the Indian Islands (Lakshadweep/Andaman group of islands) and coastal areas, and to make the islands/areas ‘Fossil Fuel Free’ (3F) by 2035.

You will design and optimize a marine energy systems. It is a computational/experimental work to address some of the above issues. Numerical model are used to predict the system performance while the optimization models help to get the best performance from it. The experiments will help to cross verify the optimized model.

Currently, several PhD/MS students in my research group in Wave Energy and Fluids Engineering Lab are working on marine energy turbines/control/optimization. <Ongoing research projects: UK-India joint project and NIOT’s wave energy project.>

<<If you want to be a part of my team, please contact me at: samad@iitm.ac.in, Whatsapp: 095 0013 0279. Please visit my department webpage or Facebook page: https://www.facebook.com/wefelab/>>

Wave-energy turbine
Are you interested in coding in Matlab? You can join my team to modify an existing optimization code which I wrote sometimes back. We will modify the code and develop an automated optimization strategy for engineering systems design. We will implement the code in ocean/petroleum engineering related research areas. *There is an opportunity to complete a part of the PhD thesis at a University in Europe*

**Numerical/ experimental analysis/ optimization of pumps for oil and gas industry applications**

Typically oil industry pumps multi-phase/multi-component fluids. Through this project, CFD/ experimental analysis will be done. A design optimization will also accompany the research. We have developed experimental setup for these and we are able to test with new designs.

Response surface to enhance efficiency through optimization strategy

Pump experimental facility. Optimized pumps are tested here.
Areas of Research Interest

- Ship Hydrodynamics: Resistance and Seakeeping
- Biomimetic Propulsion and Control of Marine Vehicles
- Finite-Difference Analysis of Nonlinear Wave Hydrodynamics

Current Research Topics

- Flapping-Foil Propulsion of Underwater Vehicles.
- Seakeeping of Multihull and Surface Effect Ships
Proposed PhD Research Topics - 2016

• HYDRDYNAMIC ANALYSIS OF FLAPPING FOILS AND UNDULATING WINGS FOR PROPULSION AND MANEUVERING OF MARINE VEHICLES

• COMPUTATIONAL STUDY OF WAVE AND FLOW ENERGY CONVERSION USING FLAPPING FOILS

• ANALYSIS OF VEHICLE-GENERATED NONLINEAR INTERNAL WAVES

• DESIGN, ANALYSIS, SYSTEMS INTEGRATION AND DEVELOPMENT OF A BIOMIMETIC UNDERWATER VEHICLE (As a co-guide along with another faculty member with expertise in design and systems integration of marine vehicles)
Field of Research Interests

- PROPULSION DYNAMICS
- COMPUTER AIDED DESIGN FOR OCEAN VEHICLES
- EXPERIMENTAL SHIP HYDRODYNAMICS, CFD APPLICATIONS

- Wake adapted propellers, Optimization, VLM analysis and design
- Computer aided ship surface development, design
- Powering, energy conservation, dynamic loads and effects, motions and motion control
Computer aided analysis of ship and offshore structures, Dynamics of floating bodies, Ocean and underwater acoustics.

**Current Research Interests**

- Fatigue and fracture studies in offshore structures
- Shallow water ocean acoustic propagation with seabed penetration
- Floating multi-body dynamic interaction using CFD
- Analysis of vortex induced vibration (VIV) of slender structures and VIV induced fatigue
- CFD analysis of water entry and exit problems
- Dynamics (maneuvering) of underwater vehicles (AUV, sea glider)
- System identification in maneuvering and multi-body dynamics
- Nonlinear dynamics of compliant/moored offshore structures
- Risk engineering of offshore systems
Field of Research Interests

- Nonlinear dynamic analysis of offshore compliant structures
- Earthquake resistant analysis and design of structures
- Modal pushover analysis of framed structures, Base isolated structures
- Semi-active damping devices for response control of structures
- Seismic analysis of offshore structures, Shell structures under shock and impact loads.

Current Research Interests

- **Dynamics of offshore structures**
  
  Topic of research: Dynamic analysis of Floating Storage Regasification Unit (FSRU) under environmental loads

- **Deep water offshore structures**
  
  Topic of research: Stability analysis of offshore triceratops
Dynamics of offshore structures
Topic of research: Dynamic analysis of Floating Storage Regasification Unit (FSRU) under environmental loads
• Scope: With the rise in LNG demand in Asia, lingering question how to import LNG faster, sooner and at a much cheaper price. FSRU come as quick-fix solution for this surge in LNG need.
• The research work will focus on dynamic analysis of new innovative FSRU that can house large LNG containers.
• Concepts of dynamics of floating bodies and compliant type structures shall be employed in the study.
• Research work shall have both the components of experimental and analytical investigations.

Deep water offshore structures
Topic of research: Stability analysis of offshore triceratops
• Scope: Offshore triceratops are new innovative type deep water offshore compliant structures that are currently being investigated worldwide. The structural geometry claims several advantages of counteracting the environmental loads; but stability of such platforms need more insight.
• Proposed research shall address the stability analysis of offshore triceratops under regular wave loads and also under shock and impact loads. Concepts of Mathieu's stability of complaint structures along with basics of stability analyses shall be addressed.
• Research work shall be purely based on analytical investigations only.
FACULTY: DR. DEEPAK KUMAR

Field of Research Interests

The focus of Dr. Deepak Kumar research is to develop Mathematical and computational model and if possible its validation using experimental results. The application areas are mainly Civil and Offshore structures.

- Stochastic dynamics of structure
- Stochastic structural control and stability
- Time-frequency analysis of nonlinear structure
- Experiments related to structural dynamics
- Study on chaotic behavior of structural response

Current Research Interests

- Stochastic nonlinear control of structural response control and its stability

Dynamic response control of important buildings are very important for occupant comfort and structural integrity. When loading is stochastic, structural control is called stochastic structural control and it involves stochastic mathematics. Stochastic control of structural response is always a difficult and interesting topics among researchers. Further difficulties added to this type of problem is significantly high, if nonlinearity in structure and controlling device is considered. This topic is relatively new and interesting to explore the new dimension.
Stochastic nonlinear control of structural response and its stability

- Control devices are used to achieve response control
- Control devices are: TMD, Damper, Semi-active-TMD etc.
- Stochastic differential Eq. are need to be solved for the same

Passive control of structure and optimization of controlling device parameter

- Multi-Tuned mass damper (MTMD) is a effective control device
- It’s efficiency can increase if parameters are optimized correctly
- Damping and stiffness of structure can also be optimized along with MTMD to obtain maximum structural control

Time-frequency analysis of nonlinear structure under stochastic loading

- This is new development in research for structural analysis
- It utilizes wavelet transform to obtain the response in time-frequency domain
- This tech. gives better information about structure behavior than classical techniques available in literature
• Enhanced Oil Recovery – applications of nanotechnology
• Gas Hydrates – recovery, utilization, storage and flow assurance
• Flow Assurance – Computational Fluid Dynamics studies in microchannels (single phase and multiphase flows)
• Rheology of Complex Fluids
FACULTY: PROF. P. KRISHNANKUTTY

Field of Research Interests

- Bio-inspired marine vehicle propulsion systems
- Ship maneuvering and motions
- Ocean wave-structure interaction
- Ship-to-ship hydrodynamic interaction
- High-speed vessel passenger comfort and wave wash study

Current Research Interests

- **Experimental Ship Hydrodynamics**
  1. Flapping foil propulsion system in marine vehicles (PhD).
  2. Use of PMM to study marine vehicle controllability (PhD).
  3. Shallow water effects on ship controllability (PhD)

- **Numerical Ship Hydrodynamics**
  1. Effects of waves on surface ship maneuvering (PhD/MS)
  2. Effect of propeller and rudder on maneuvering coefficients. (PhD/MS)
  3. Hydrodynamic interaction of ships (MS).
  4. Ship mount wind turbines (MS)
FACULTY: PROF. K. MURALI

Field of Research Interests

- Software development for Coastal currents, sediment transport, sea bed changes
- Climate Change Induced Ocean Circulation & Coastal Pollutant
- Protection against tsunamis and storm surges
- Marine Renewable Energy; VIV energy enhancement.

Project: Hydrodynamics & Stability of Artificial Reefs

Use of reefs in Tsunami wave mitigation. Application to coastal erosion protection.

Seabed with Artificial Reef

RESEARCH ISSUES

- Laboratory experiments using model reef structures.
- Computer simulation of wave breaking and sediment transport.
**FACULTY: PROF. K. MURALI**

**Marine VïO Energy Challenges**
- CFD Computation of VIV.
- Increase energy efficiency and availability.
- Active VIV control.

**Isolated Buoy Wave Energy Converters**
- Feasibility of Wave Energy conversion.
- Study of Structural Dynamics.
- Wave – Buoy interaction.

**Indian Ocean Currents under Global Warming**
- Effects on Antarctica Bottom Currents.
- Climate issues of Indian waters.
Field of Research Interests

- Wave Structure Interaction.
- Soil Structure interaction problems
- Offshore Wind Energy
- Multi-body dynamic response of FPSO and LNG vessels
- Hydrodynamic Response of Spar Hulls

Research Topics available

**Soil Structure interaction problems**
- Effect of opening on the Jacket mud-mat capacity
- Axial and Lateral capacity of driven piles in the vicinity of Jackup spud mark
- Effect of pile spacing on lateral capacity of driven steel piles

**Fluid Structure interaction problems**
- Hydrodynamic response of turret moored FSRU and LNG vessel
- Dynamic analysis of tension leg jacket spar
- Hydrodynamic simulation of float-over installation of large topsides
- Minimum structures for marginal field development
Hydrodynamic Response of Spar hulls

The experimental and CFD analysis on various hull shapes of Spar hulls with differing shapes and damping elements.

Flow visualization: PIV image-L

The experimental and CFD analysis on various hull shapes of Spar hulls with differing shapes and damping elements.
FACULTY: PROF. S. NALLAYARASU

Current / Ongoing Research Work

Effect of bilge keel on roll damping of ships.
Coupled dynamic response of wind turbine with Spar
FE Analysis of Stiffened Tubular connections
Offshore wind turbines – Experimental analysis of wind turbines
Offshore wave energy
Dynamics of offshore structures.
Nonlinear analysis of ocean structures under random waves.

Topic 1: Offshore wind turbines,
Topic 2: Offshore wave energy,
Topic 3: Numerical hydrodynamic modelling of ocean waves.
Topic 4: Stochastic analysis of ocean structures.

Would be interested to work on other topics with mutual interest as nonlinear problems, wave structure interaction, etc.

Prerequisites from candidates:
Basic knowledge of computer programming.
Air Plane & Birds

Wind

Waves

SEA

SEA BED

Anchors

Offshore Structure with the Wind Turbine/Wave Energy Converter

forces are: time varying – dynamic and random

For Design: Structural response is required ???

For environmental loads

Topic: Experimental analysis of offshore wind turbines under environmental loads
Topic: Analysis of wave energy buoys in a grid system.

Dr. Nilanjan Saha
Topic: Numerical modelling of hydrodynamic phenomena

Waves propagation follows a model of differential equation

IDEAL CASE

WAVE Equation:
Solution of the same numerically.

PRACTICAL SCENARIO

Reason is randomness:
Waves propagation follows a similar model of differential equation with ocean random properties

Goal: Obtain the solution of these differential equations.

Dr. Nilanjan Saha
• Hydrodynamic Analysis of Offshore Structures
• Parameter Identification of Ocean Engineering Systems
• Nonlinear Dynamic Analysis of Offshore Structures

(i) Numerical and Experimental studies on Floaters for offshore wind energy
(ii) Emerging New Concepts of Offshore structures for Oil and Gas industry – Numerical and Experimental studies

(i) Identification of parameters of floating offshore structures – includes ships in waves and calmwater
(ii) Simulation of motion of ships in seas and calmwater (maneuvering)

Simulation of nonlinear responses of offshore floating systems
Numerical and Experimental Investigations on nonlinear behaviour of offshore structures

Nonlinear responses of typical offshore structures – compliant such as articulated towers, Tension Leg Platform, Guyed towers as well as floating structures such as Spars, FPSOs, Buoys will be investigated.

The focus of the research will be to simulate nonlinear responses such as subharmonics, superharmonics, period doubling phenomena, chaotic behaviour etc. of such systems.

The simulated response will be verified by a scale model of the prototype and testing in the wave basin.

Parameter Identification of offshore systems from simulated and experimental data

Focus of research will be identifying the parameters of governing equation of motion of linear and nonlinear model of offshore systems.

Simulated Free vibration responses / responses/ forces will be used to identify parameters.

Modeling of simple systems in wave basin to obtain free vibration responses and identify parameters of interest.
Investigations on coupled dynamics of submarine pipe laying vessels
Focus of research is to simulate responses of pipe laying vessels under different conditions of loading and laying.

Experimental investigations on pipelaying barges with stringer and pipelines under different conditions

Analysis, design and development of new types of offshore structural systems for offshore industries and energy sector
Investigations on coupled dynamics of Tension based tension leg platform – Experimental and Numerical analysis.

Investigations of coupled dynamics of TBTLHP and Riser tower.

Dynamics of offshore wind turbine on a floating system including gyroscopic effects.

Innovative new type of floating systems for offshore wind turbine.

VLFS – Very Large Floating Structures- Hydro elastic analysis
Experimental and numerical studies of Large structures with hydro elastic effects

DST-RCN RESEARCH PROJECT: Hydrodynamic loads on offshore wind turbine substructures due to nonlinear irregular breaking, high steep and extreme waves – Ph.D.
FACULTY: Dr. RAJESH R. NAIR

Field of Research Interests

Geo mechanics, Seismic Inversion, Hydro fracturing for Shale Gas studies, Gas Hydrates

Current Research Interests

Seismic & GPR Geomechanical analysis for well pad stability

Petrophysics of Shale & reservoir rocks using Laser Doppler Vibrometer measurements

Non linear optimization using Seismic attributes for well log prediction
Hydro-fracturing simulation & laboratory analysis of shale rocks
Geo mechanical analysis of well pad based on Seismics & GPR (Ground penetrating radar)

Finite element analysis of the area to establish a well pad

Shows effective stress (Pa)

Displacement in Y direction (m)

Shows effective strain

Radargram showing subsurface layers
Hydro-fracturing equipment set up for Shale gas studies

Estimation of stress and geo mechanical properties from seismic data

Reservoir heterogeneity using Laser Doppler Vibrometer set up

Propagation of elastic waves within a rock sample is determined by stiffness tensor and density of material. Stiffness tensor, phase slowness and polarizations are related by the expression:

$$C_{ij} = \frac{\rho}{\mu} a_i a_j$$

Where $C$ is the polarization and $P$ is phase slowness $A$ is polarization and $\rho$ is density of material. Phase slowness has the direction of phase velocity and its magnitude is reciprocal to phase velocity.

EXPERIMENTAL SETUP

Experimental setup of LDV

Geomechanics from seismic data

Young's Modulus

30 GPa
- Design of deep-water drilling solutions and floating structures;
- Computer aided geometric design, computational geometry, visualization, and their applications in design, robotics and manufacturing;
- Dynamic data driven forecasting systems;
- Bio-inspired propulsion systems; and
- Iso-geometric analysis for fluids and structures.
Field of Research Interests

- Laboratory investigation of Fluid-Structure Interaction & Wave Impact on offshore structures
- Wind-wave modelling and Data Assimilation
- Numerical simulation of Nonlinear free surface waves

Current Research Interests

- Numerical Modelling: FEM, SPH, LBM
- Wave Impact on Offshore Structures
  - Numerical & Experimental Study
- Geotechnical stability of breakwaters
  - FEM Modelling
- Wave Forecasting Modelling & Assimilation
Proposed PhD research topics

Impact response analysis of Offshore Structures

... through strain and acceleration measurements & Structural impact analysis
.... Fluid-Structure Interaction

Ship capsizing under extreme waves

... hydrodynamic stability
... numerical simulation

Geotechnical stability of rubble mound breakwaters

... PLAXIS modeling
... Ground improvement techniques
Field of Research Interests

Ocean Optics and Remote Sensing: Interested in studying, both theoretically and experimentally, different aspects of the Ocean Optics and Remote Sensing.

- Algorithm/ Model development
- 3-D characterization of underwater light fields
- Radiative transfer modeling of underwater light fields
- Underwater imaging
- Synergy between underwater optics and acoustics
- Coastal marine hazards & management
- Satellite oceanography

Potential Applications

- Underwater light fields and visibility, search and recovery, underwater optical communication, underwater object detection, sediments transport, dissolved carbon transport, detection of ocean biological hazards, Oil spill, bathymetry, internal waves, currents, eddies, fronts, and climate prediction, Sea floor characterization, and coastal processes/marine pollution
Field Deployments and Measurements in Coastal Waters / Applications

- **Sea surface height anomaly and geostrophic currents in winter (Tholkapiyan and Shanmugam, 2013)**

- **Remote sensing of waters**
  - New scattering phase function (Sundarabalan and Shanmugam, 2013)
  - Underwater optical communication
    - Ocean biological hazards (Shanmugam, IEEE 2013)
    - Sea surface height anomaly and geostrophic currents in winter (Tholkapiyan and Shanmugam, 2013)

- **Underwater light fluctuations under different surface and solar zenith conditions**
  (Sundarabalan and Shanmugam, 2013)

- **Underwater detection and typing**

**FACULTY:** Prof. P. SHANMUGAM
FACULTY: Dr. V. Sriram

Field of Research Interests

- Numerical modeling/computational hydrodynamics
- Meshfree methods
- Hydro-elasticity
- Violent wave-current-structure interactions
- Experimental wave generation/PIV

Current Research

- Coupling of numerical methods
- Experiments
- Wave overtopping

http://www.doe.iitm.ac.in/vsriram

Email: vsriram@iitm.ac.in
Research Topics:

- Numerical modelling on the effect of ship wakes impact on the inland national waterways.

- Violent wave- 3D Floating body interactions (Indo-UK Research project)

- Advanced 3D Numerical modelling to address the wave overtopping and runup around the corner of the Sea dikes/Sea walls. (‘Joint Doctoral Program’ – IITM & RWTH Aachen, Germany. Co-guide: Prof. H. Schuettrumpf, RWTH)

- Turbulence/two phase modeling.

- 3D wave – current Interactions

- PIV measurements on the hydro-elasticity using High Speed Camera.


http://www.doe.iitm.ac.in/vsriram

Email: vsriram@iitm.ac.in
Field of Research Interests

- Coastal Engineering including tsunami mitigation measures
- Port and harbour structures
- Fluid flow problems
- Wave Loads on Structures/ Wave Energy
Deep Water Offshore Structures
Port Infrastructure for VLCC and 18000 TEU Vessels
OTEC, Offshore Wind Energy and Desalination

NON-SHIP SHAPED FPSO FOR GAS FIELD LNG TRANSPORT
DREDGING NEW MOUTH IN CHILLIKA LAKE FOR PROTECTION OF WET LAND
MODEL STUDY ON BERM BREAKWATER
Dynamic response of moored and interconnected floating bodies

Non-linear soil structure interaction of piles on sloping ground

Hydrodynamics of intake wells

Hull-Tether-Riser Dynamics of Deep water tension Leg Platforms.

Hydrodynamic behavior of jacket spar platform with cold water pipes.

Hydrodynamic response of Spar platform with 5MW wind turbine

Geotube saline embankment
Field of Research Interests

- Ship motion dynamics and control including model testing.
- Design and analysis of marine parts using composite like alternate materials.
- Impact analysis of welded joints for marine applications, underwater applications, simulation and modeling of ballistics.
- Fracture mechanics of marine structural parts.
Research work is expected to make publications in the leading journals with good Impact Factors. This will secure the future of the researcher. So far research works were published in leading Ocean Engineering Journals like:
7. Journal of International Ship Building. IJKNAOE (list incomplete….)
Papers are also published in the proceedings International Conferences like OMAE, ISOPE etc.
Research work will be based on Numerical Simulation (Matlab, Python, C++, FORTRAN etc.,), Computer Simulation (Ansys, Abaqus, Ship Flow, Max Surf, Para Marine using Super Computers etc.) and Experiments (Flumes, Basins, Towing Tank, with support of FRP, Central Work Shop and Central Fabrication Facility etc.). Keeping active and lively contact with S. Korean Universities.
Major Areas of Research

- Statistical signal processing methods, propagation models for ocean acoustics
- Acoustical oceanography using active and passive methods
- Inverse scattering methods

Present research projects in ocean acoustics:
- Acoustic tomography, non-linear inverse methods
- Propagation model based signal processing methods to account for ocean variability
- Acoustic models for Indian waters, experiments
**FACULTY: DR. R. Vijayakumar**

**Field of Research Interests**

- Experimental and Numerical Ship Hydrodynamics
- Warship and Submarine design
- Warship propeller Design

**Current Research Interests**

- Ship helo Interface
- CFD and experimental study of vertical Launch missile from static and mobile platform
- Development of UW glider
- Developing safety envelope during firing of torpedoes from Submarine
- Application of green technology like energy saving devices for improving propulsion efficiency.
Proposed PhD research topics

Effect of stern flap in improving propulsive efficiency

... Involves experimental and CFD analysis

Development of propeller design curves for low noise propeller

... Experimental
... numerical simulation

Development of Under water gliders

... A complete product development
You may meet as many faculty members as possible for discussion to finalize your choice(s).

Submit your first 3 choices to HoD preferably before 3 pm on 3 Jan 2017.

All the very best