##### **MODULE DESCRIPTION FORM**

1. **Finite Element Analysis for Marine Structures**

|  |  |  |
| --- | --- | --- |
| **Module Code: 21452** | **Module Title: Finite Element Analysis for Marine Structures** | |
| **Module Registrar: Dr Erkan Oterkus** | | |
| **Other Lecturers Involved:**  **N/A** | **Credit Weighting:**  **10** | **Semester:**  **1** |
| **Compulsory/optional/ elective class:**  **Compulsory** | **Academic Level: 4** | |

**Module Format and Delivery (hours):**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lectures** | **Tutorials** | **Assignments** | **Private Study** | **Total** |
| **22** | **11** | **7** | **60** | **100** |

##### **General Aims**

|  |
| --- |
| To provide students with a theoretical and practical knowledge of the finite element method and the skills required to analyse marine structures with ANSYS graphical user interface (GUI) |

##### **Specific Learning Outcomes**

|  |
| --- |
| LO1 An understanding on the basics of finite element analysis  LO2 An understanding of how to perform finite element analysis by using ANSYS graphical  user interface  LO3 An understanding on specifying necessary input parameters for the analysis  LO4An understanding on how to apply boundary conditions  LO5 An understanding on how to apply symmetry conditions  LO6 An understanding on how to visualize and evaluate the results |

**Syllabus**

|  |
| --- |
| 1. Introduction to finite element analysis and ANSYSGraphical User Interface (GUI) 2. Truss elements and applications 3. Solid elements and applications 4. Beam elements and applications 5. Plane stress, plane strain and axisymmetry concepts 6. Plane elements and applications 7. Plate & shell elements and applications 8. Assembly process and constructing of the global stiffness matrix |

##### **Assessment Method(s) Including Weighting Percentage and Duration of Exams**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coursework** | **No. of class tests& assignments** | **3 class tests & 1 assignment** | ***Weighting %*** | **100** |
| **Resit :**  **Examination only** | ***Duration*** | **2 hours - August** | ***Weighting %*** | **100** |

**The class tests will be in weeks4, 7 and 10 of the first semester.**

**2. High performance Sailing Yachts**

|  |  |  |
| --- | --- | --- |
| **Module Registrar: Prof A H Day** | **Taught To (Course): MEng/BEng NA** | |
| **Other Lecturers Involved: N/A** | **Credit Weighting: 10** | **Semester: 1** |
| **Assumed Prerequisites: NM305** | **Compulsory class** | **Academic Level: 4** |

**Module Format and Delivery (hours):**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Lectures** | **Tutorials** | **Laboratory** | **Project** | **Assignments** | **Private Study** | **Total** |
| **24** | **12** |  |  | **16** | **48** | **100** |

**Educational Aim:**

|  |
| --- |
| This module aims to illustrate how aero-hydrodynamic theory may be applied in practice in performance prediction (VPP) for high performance sailing yachts and to provide an in-depth insight into the particular hydrodynamic challenges posed to designers of high speed high speed sailing yacht design concepts. |

**Learning Outcomes:**

|  |
| --- |
| On completion of the module the student is expected to be able to  LO1 Understand the generation of different components of drag and lift with practical application in yacht Keels, sails and hydrofoils.  LO2 Understand the nature and limitations of velocity prediction programs (VPPs) for displacement sailing yachts.  LO3 Understand the calculations involved in a simple VPP for a displacement yacht, and how they may be implemented in a practical design tool.  LO4 Understand the nature of developments required to support and implement more sophisticated VPPs including tank testing approaches for sailing yachts, implementation of yaw balance, and the challenges of VPPs for dinghies and foil supported vessels. |

**Syllabus**

|  |
| --- |
| The module will teach the following:   1. Introduction to Velocity Prediction Programs (VPPs) for sailing yachts: equilibrium in horizontal plane forces and heel moments. Aero- and hydrodynamic models. Requirement for iterative solution. Presentation of results via polar plots. 2. Fundamental concepts of Sailing yachts (revision): Equilibrium of a sailing yacht: horizontal plane forces, heel trim & yaw 3. Hydrodynamic forces on a yacht 1. Decomposition: Upright, heeled and sideforce components. Resistance “deltas”. Upright resistance, frictional & wave pattern resistance by Delft method. Appendage resistance (viscous & wave pattern). 4. Hydrodynamic forces on a yacht 2: effect of heel on frictional and wave pattern resistance of hull and appendages. 5. Lift & drag in 2D & 3D: revision. 6. Hydrodynamics forces on a yacht 3: effect of sideforce on induced drag. 7. Prediction of Yacht Sail Aerodynamics 1: Force decomposition, upwind & downwind rigs, sail areas, apparent wind angle, effect of heel. 8. Prediction of Yacht Sail Aerodynamics 2: Calculation of Lift, Viscous Drag & Induced Drag. 9. Drive and heeling force coefficients. Heeling moment calculations. 10. Velocity Prediction Program (VPP) solution for speed and heel angle. Calculation procedure, convergence criteria, practical implementation, failure to converge. 11. Modelling depowering: Use of REEF, FLAT & TWIST 12. Challenges of tank testing for sailing yachts 13. Foil supported and foil-assisted vessels 14. Advanced VPPs: yaw balance, sailing dinghies, hydrofoil vessels |

**Assessment Method(s) Including Percentage Breakdown and Duration of Exams**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Examinations** | | | **Courseworks** | | **Projects** | |
| Number | Duration | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** |
| 1 | 2 | 75 | 2 | 25 |  |  |
| LO1-4 |  |  | LO1-3 |  |  |  |

**3. Seakeeping and Manoeuvring**

Module Code: NM 423

Module Title:

Seakeeping and Manoeuvring

Module Registrar: Dr P G Sayer

Other Lecturers Involved:

Dr Zhiming Yuan

Credit Weighting: Semester:

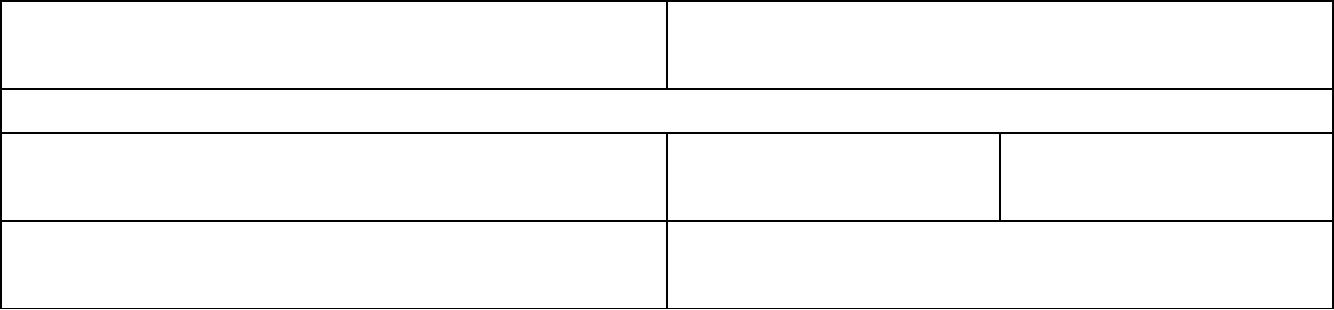
20

1

Compulsory/optional/ elective class:

Compulsory

Academic Level: 4



Module Format and Delivery (hours):



Lectures Tutorials Assignments Private Study Total

40 26 34 100 200

General Aims

To demonstrate the important seakeeping characteristics of marine vehicles and explain the

factors influencing this behaviour; to identify the factors determining the manoeuvrability of a

marine vehicle; to study the implications to design and operability.

Specific Learning Outcomes

LO1 To acquire a knowledge of those design and operational parameters affecting ship

motions; to be able to calculate the wave loading and response of ships and floating offshore

platforms.

LO2 To evaluate the contributions of the main design and environmental parameters on the

dynamic behaviour of a ship in a seaway.

LO3 To understand the purpose of manoeuvring trials; to be able to analyse model and full-

scale data and their implications to design and performance.

Syllabus

Seakeeping - Dr P G Sayer

Importance of Seakeeping

1. Formulation of equations of motion:

2. Frequency-domain and time-domain.

3. Mathematical modelling; dynamic system parameters

4. Practical interpretation and implications to design and operation.

Motion Modelling

5. Linear equations of motion I.

6. Linear equations of motion II.

7. Coupled motions

8. Multi-degrees of freedom.

9. Transformation of coordinates.

10. Extracting the important information: non-linearities.

11. Phase-plane methods.

12. Spectral techniques I – recap of important principles.

13. Spectral techniques II – response and motions.

14. Spectral techniques III – response and motions.

15. Spectral techniques IV – extreme values.

Hydrodynamic Force Modelling

16. Potential theory; boundary conditions and panel methods.

17. Simplifying the real world: diffraction.

18. Simplifying the real world: radiation.

19. Strip Theory and Morison’s equation I.

20. Strip Theory and Morison’s equation II.

21. Froude-Krylov loads.

22. Added mass.

23. Hydrodynamic damping.

24. Drag.

25. Non-linearities.

26. Stokes drift and momentum I.

27. Stokes drift and momentum II.

28. Moving frames of reference.

29. Relative motions: two-degrees of freedom example.

30. Time-varying restoration: Mathieu equation.

Manoeuvring - Dr Zhiming Yuan

31. Course-keeping and turning

32. The need for standard trials.

33. Turning circle, pull-out, stopping.

34. Zig-zag and spiral manoeuvres.

35. Experimental facilities – towing tanks, circulating arms, planar motion mechanisms.

36. Analysis of model and full-scale data.

37. General equations of motion.

38. Directional stability and turning.

39. Stability indices and criteria.

40. Interpretation of criteria.

Assessment Method(s) Including Weighting Percentage and Duration of Exams

Weighting 60

%

Weighting 40

%

Examination

Coursework

Duration

3 hours - December

3 inc. class test

No. of assignments

Duration

Resit

3 hours - August

Weighting 100

Examination

%

**4. Ship Structural Dynamics**

|  |  |  |
| --- | --- | --- |
| **Module Code: NM404** | **Module Title: Ship Structural Dynamics** | |
| **Module Registrar: Dr T Tezdogan** | | |
| **Other Lecturers Involved: -** | **Credit Weighting: 10** | **Semester: 1** |

|  |  |  |
| --- | --- | --- |
| **Assumed Pre-requisites**  NM313, NM312, NM318 | **Compulsory class** | **Academic Level: 4** |

**Module Format and Delivery (hours):**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Lecture | Tutorial | Laboratory | Project | Assignments | Private Study | **Total** |
| 22 | 11 |  |  |  | 77 | 100 |

##### Learning Outcomes

|  |
| --- |
| On completion of the module the student is expected to be able to:   * To acquire a knowledge of those design and operational parameters affecting ship motions; to be able to calculate the wave loading and response of ships and floating offshore platforms. * To understand the role of structural dynamics in ship design * To evaluate the contributions of the main design and environmental parameters on the dynamic behaviour of a ship in a seaway. * To use analytical and numerical techniques for modelling and analyses of vibration response. * To devise a rational approach for minimum vibration in the design and post-design stages. |

##### Syllabus

|  |
| --- |
| The module will teach the following:  Dynamic system parameters: bending and shear stiffness, added mass, hydrodynamic and structural damping; coupled modes; experimental measurements and validation.  Dynamic Systems, Excitation Sources and Vibration Response (20 lectures)  **General Introduction to Marine dynamics**   1. Basic terminology. Periodic and harmonic motions. Degrees of freedom. Natural frequencies and modes of vibration. The phenomenon of resonance.   **Mathematical modelling of linear systems**   1. Single-degree-of-freedom systems; free, damped, forced vibration. Multi-degree-of-freedom systems.   **The dynamic system- System parameters**   1. Bending stiffness, shear stiffness, rotary inertia. 2. Added mass and damping. 3. Appropriate methods to calculate added mass and damping.   **Excitation Sources**   1. Periodic, machinery excitation. 2. Propeller excitation, steady state wave excitation. 3. Impulsive excitation and Slamming. 4. Nature of slamming, Slamming theories. 5. Occurrence and severity of slamming. Preventative measures and criteria.  Vibration Response – Ship Hull Vibrations  1. Uniform beam; Euler, Bernoulli, Rayleigh and Timshenko beams 2. Solutions for free and forced vibrations. 3. Semi-empirical and empirical methods, applications. 4. Non-uniform beam - Generalised Iterative Method, applications.  Local Vibration  1. Superstructure vibration. 2. Propeller bossing, shafting vibration.   **Levels of Vibration**   1. Methods of approach, human reaction to vibration, guidelines for assessment, ISO recommendations.   **Design Guidelines**   1. Approaching vibration problems at the design stage and post-design corrective actions, vibration measurements and costs. |

##### Assessment Method(s) Including Weighting Percentage and Duration of Exams

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Examinations** | | | **Coursework** | | **Class Test** | |
| Number | Duration | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** |
| 1 | 2hrs | 70% | 0 | - | 1 | 30% |
| LO1 and LO2 | | |  |  | LO1 and | LO2 |

**5. NM402 Theory and Practice of Marine CFD**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module Registrar:Dr** Q Xiao | | | | | **Taught To (Course):**MEng / BEng Naval Architecture students. | | | | | |
| **Other Lecturers Involved:** | | | | | **Credit Weighting:**10 | | | **Semester:**1 | | |
| **Assumed Prerequisites:**Mathematics, Hydrodynamics | | | | | **Compulsory class** | | | **Academic Level:**4 | | |
| **Module Format and Delivery (hours):** | | | | | | | | | | |
|  | Lecture | Tutorial | Laboratory | Project | | Assignments | Private Study | | **Total** |
|  | 15 | 15 |  |  | | 35 | 35 | | 100 |
| **Educational Aim** | | | | | | | | | | |
| * To introduce the students to the theoretical background of marine CFD using the finite volume method * To illustrate the key ideas related to discretisation and solution of the Momentum and Navier-Stokes equations for incompressible flows * To discuss some key issues related to the use of CFD packages in practical applications   . | | | | | | | | | | |
| **Learning Outcomes** | | | | | | | | | | |
| On completion of the module the student is expected to be able to  LO1 Be familiar with the basis for the key equations of CFD for incompressible flow in finite volume form.  LO2 Understand in principle how these equations may be discretised and solved numerically.  LO3 Apply commercial CFD package to a simple 2D engineering problem. | | | | | | | | | | |
| **Syllabus** | | | | | | | | | | |
| The module will teach the following:   * Introduction of CFD and its application * Governing equations and their simplified forms * Discretization of governing equations and boundary conditions * Spatial Discretization   1. Finite difference method, finite volume method, finite element method   2. Convective term discretization schemes   3. Numerical mesh generation   4. Boundary conditions * Temporal Discretization   1. Implicit and explicit and other schemes * Converting governing equations to algebraic equations system * Solution of discretised equations * Direct and iterative method * Solution algorithms for Pressure-velocity coupling –SIMPLE scheme | | | | | | | | | | |

**Assessment Method(s) Including Percentage Breakdown and Duration of Exams**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Examinations** | | | **Courseworks** | | **Projects** | |
| Number | Duration | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** |
| 1 | 1.5 | 85 | 1 | 15 |  |  |
|  | | |  | |  | |

**6. Curriculum design（1）**

**Except where stated, all the problems should be solved using an Excel Spreadsheet.**

**You are provided with a macro-enabled Excel sheet which**

**a) solves the upright resistance of a yacht hull and**

**b) includes a cubic spline function which you can use (called sspline)**

**You will each be given data for a yacht which you should use for this coursework**

a) the righting moment of a yacht for a given heel angle, based on tabulated data for GZ;

b) the heel angle for a yacht subject to a known righting moment.

1) the dimensions and coefficients listed for your specified yacht

2) the **righting moment** curve for your specified yacht, tabulated for a range of heel angles from 0 to 35 degrees at 2.5 degree intervals (use the spline function)

3) The righting moment for your specified yacht for a heel angle of 19 degrees (use the spline function)

4) The heel angle required for a righting moment of 4250Nm (use the spline function and the goalseek function)

3) Using the coefficients in the supplied excel sheet, develop an Excel spread sheet which will calculate:

a) the upright resistance of a yacht + keel over the tabulated range of Froude Numbers

b) the upright resistance at any given speed

c) the change in wetted surface area over the tabulated range of heel angles

d) the change in frictional resistance due to heel at any heel angle and speed

e) the change in the residuary resistance of the hull due to heel at 20 degrees heel angle over the tabulated range of Froude numbers

f) the change in residuary resistance of the hull at any heel angle and speed.

g) The change in residuary resistance of the keel at any heel angle and speed

h) The effective draught at any heel angle and speed

i) The induced resistance at any given speed / heel angle / heeling force.

j) And thus: the total resistance at any given speed / heel angle / heeling force.

1. a hand calculation for each component of resistance for your yacht in order to validate your solution, calculated at Fn=0.30, phi=20 degrees, Fh = 3250 N. Compare this with the output from your spreadsheet.

b) the **complete** tabulated results for upright resistance of your yacht.

Show intermediate steps in your calculation. For each Froude Number show:

1) Reynolds number Canoe Body,

2) Friction coefficient Canoe Body,

3) Friction Resistance Canoe Body,

4) Residuary Resistance Coefficient Canoe Body

5) Residuary Resistance Canoe Body

6) Reynolds number Keel,

7) Friction coefficient Keel,

8) Viscous Resistance keel

9) Wave Resistance Coefficient Keel

10) Total Resistance Keel

c) The tabulated variation of wetted surface area with heel angle

d) The tabulated variation of residuary resistance delta at 20 degrees heel with Froude Number

e) Final results for all components of resistance of your yacht with speed of 3.5 m/s, heel angle = 24 degrees, heeling force = 3500N

**7. Curriculum design（2）**

**（1）Develop an Excel spread sheet which will calculate the aerodynamic drive and heeling force and the aerodynamic heeling moment for a yacht rig consisting of a mainsail and jib for any given true windspeed and direction and boat-speed and heel angle. Assume that the vessel has a rig which qualifies for high lift coefficients.**

**（2）Link the spreadsheets calculated above to that of the previous assignment to predict the differences between:**

**a) drive and resistance**

**b) heeling moment and righting moment**

**for a given true wind speed and direction and a given boat speed and heel angle. Give results for the following case:**

**（3）Use this in conjunction with the “goalseek” function to find the speed of the boat for the wind conditions outlined above by setting drive-resistance = 0 at a fixed heel angle of 22.0 degrees. Calculate the discrepancy between heeling and righting moment in this condition.**

**Your submission should include a brief explanation of the method, a printout of the spreadsheet, and a copy of the spreadsheet with your solution.**

**8. Curriculum design（3）**

For the truss shown in Fig. 1, determine the nodal displacements and stresses in each elementby using hand calculations. At node 2, there is a pin joint (no translation in all directions) and atnode 1, there is a roller joint (no translation in vertical direction). Each member has a circularcross-section area of 10 in2. Each member has an elastic modulus of E=29e6 psi and Poisson’s ratio of 0.3. Verify your result by comparing against ANSYS solution.

****