DEPARTMENT OF APPLIED MECHANICS

D.I.I.T. (Naval Construction)

This Postgraduate Diploma Programme in Naval Construction is open to the sponsored candidates from Indian Navy only. The semester schedule of credit requirements is as follows:

I Semester Courses

AML713	Applied Fluid Mechanics	4 credits	(3-1-0)
AML701	Engg. Mathematics & Mechanics	3 credits	(3-0-0)
AML732	Solid Mechanics	3 credits	(3-0-0)
AML791	Ship Resistance and Propulsion	3 credits	(3-0-0)
AML792	Structural Design of Ships	3 credits	(3-0-0)
AM L832	Application of Theory of plates & shells	2 credits	(2-0-0)

II Semester Courses

AML702	Applied Computational Methods	4 credits	(3-0-2)
AML751	Materials for Marine Vehicles	3 credits	(3-0-0)
AML793	Ship Dynamics	3 credits	(3-0-0)
AML794	Warship Design	3 credits	(3-0-0)
AML795	Submarine Design	3 credits	(3-0-0)
AML706	Finite Element Methods and its Applications to Marine Structures	3 credits	(3-0-0)

III Semester Courses

AML733	Dynamics	3 credits	(3-0-0)
AMD899	Design Project	10 credits	(0-0-20)

AML700 Experimental Methods for Solids and Fluids

4 credits (3-0-2)

Basic principles of experimental analysis, strain gauges and strain gauge circuits. Rosettes. Photoelasticity. Brittle coating method. Moire fringe methods, holography, etc.

Flow visualization techniques. Measurement of pressure, velocity, discharge in fluid flow. Hot wire anemometry. Hot film anemometry, laser Doppler anemometer. Instrumentation in two-phase flows. Recent developments.

AML701 Engineering Mathematics & Mechanics

3 credits (3-0-0)

Partial differential equations. Fourier Series and transforms. Calculus of variations. Newtonian and Lagrangian mechanics. Variational and Hamiltonian mechanics.

AML702 Applied Computational Methods

4 credits (3-0-2)

Algorithms. Methods of undetermined coefficients. Numerical differentiation and integration. Solution of ordinary differential equations. Solution of linear and non-linear algebraic equations. Boundary value problems and initial value problems. Numerical solution of partial differential equations. Eigenvalue problems.

AM704 Flow of Non-Newtonian Fluids and Complex Mixtures

3 credits (3-0-0)

Classification and properties of non-Newtonian fluids. Rheological parameters and flow properties. Governing equations. Flow of non-Newtonian fluids through pipes. Turbulent flows. Complex mixtures. Phase separation and setting behaviour. Fundamental concepts for flow of mixtures. Flow of mixtures through pipes. Typical flow patterns. Applications.

AML705 Finite Element Methods

4 credits (3-0-2)

Method of weighted residuals and variational approach for solving differential equations. Galerkin and Rayleigh-Ritz methods. Finite element method and implementation. Convergence criterion. Finite element formulation for linear elastic continuum and extended Laplace equation including inertia and dissipative terms. Substructuring. Co-elements including isoparametric elements. Plate bending and 'C' elements. Non-conforming elements and patch test. Dynamic and non-linear problems.

AML706 Finite Element Methods and its Applications to Marine Structures

3 credits (3-0-0)

Introduction to FEM. Variational methods. Element types and properties. Boundary conditions. Stress-strain determination. Solution techniques. Mesh refinement. Convergence criterion. Frames, beams and axial element. Plane stress. Plane strain. Axisymmetric problems. Plate bending. Fluid mechanics and heat transfer. Modules modelling and elastic analysis. Super elements. Structural instability of frames and beams.

AML710 Computer Aided Design

4 credits (3-0-2)

Principles of computer aided design. Computer configuration for CAD applications. Computer peripherals for CAD. Computer graphics fundamentals. Points and lines. Three-dimensional transformations and projections. Plane curves. Space curves. Surface description and generation. Hidden line algorithms for wireframe modelling. Surface modelling. Solid modelling, Representation of 3-D objects.

B-rep solid modellers and constructive solid geometry-CAD system utilization and application-Hidden surface algorithms and shading. Finite element systems. Computer aided drafting system.

Modelling using Solid Modeler (I-Deas) : Introduction - Part Modelling - Creating Geometry - Operations - Modifying parts - Constraints and construct Networks - Surface Modelling - Assembly - Part and Instance - Concurrent Engineering and Data Management - Drafting - Part Design.

Programming Exercises: 3-D Transformations and Projections - Curves - Surfaces - composite surfaces - CSG Modelling Tools - B-Rep Modelling Tools - Hidden Line Removal and Hidden Surface Removal.

AML711 Advanced Fluid Mechanics

4 credits (3-1-0)

Review of basic laws of fluid flow in integral and differential form, kinematics. Ideal fluid flow. Newtonian fluid flow and applications. Creeping flow. Boundary

layer theory. Transition and turbulence. Turbulent boundary layer. Fundamentals of compressible flows. Modelling and dimensional analysis.

AML712 Numerical Methods in Fluid Flows

3 credits (3-0-0)

Review of numerical methods. Application of finite difference methods to different fluid flows such as inviscid flow, boundary layer development flow through fluid machines etc. Introduction of finite element methods, different approaches for deriving element equation. Application to different fluid flow situations.

AML713 Applied Fluid Mechanics

4 credits (3-1-0)

Basic equations of fluid motion, Dynamics of ideal fluid motion, Generalised Bernoulli equation and special cases, Governing equations for viscous fluid flows, Creeping fluid flows, Boundary layer approximation, Transition to turbulence, Fundamentals of turbulent flow, Turbulent boundary layer over a flat plate.

AML714 Fluid Flow Analysis and Applications to Power Plants

3 credits (3-0-0)

Introduction to flow types, fluid statics, relative equilibrium and kinematics. Fluid flow equations for mass, momentum, angular momentum, energy and their applications. Inviscid flows. Flow through pipes and Reynolds number effects. Navier-Stokes equations and applications. Models of turbulence. Boundary layer flows. Thermal boundary layers. Boundary layers in power plant flows (case study). Pipe networks. Turbulent flows in power plant flows (case study). Plane and axi-symmetric jets and wakes and their applications in power plants (case study). Compressible flows and applications in power plants (case study). Transportation of material by fluid flows. Types of complex mixtures. Two phase flows. Phase separation and settling behaviour. Slurry pipeline transportation and applications in power plants (case study). Review of numerical methods in fluid flows. Basic principles of experimental analysis. Flow visualization techniques. Flow metering and other fluid devices for measurement of pressure, velocity, discharge, etc. and their applications in power plants (case study).

AML715 Viscous Fluid Flow

3 credits (3-0-0)

Governing equations in differential form. Navier-Stokes' equations and applications. Review of boundary layer prediction methods. Transition and turbulence. Turbulent boundary layers. Drag on bodies. Free turbulent flows. Turbulent boundary layer prediction methods.

AML730 Reliability Engineering for Power Plants

3 credits (3-0-0)

Introduction to reliability & failures, Different sub systems of power plants and understanding of their contribution in reliable operation of over all plant Reliability effectiveness criteria, Stochastic and Markove processes. Different types of failures, Normal exponential, Weibull and other failure distributions. Flow graphs and reliability. Reliability models of maintained and non-maintained systems, series, parallel, stand-by and mixed configuration. Allocation of redundancy. Reliabilitic designs using existing quality components, weight, volume and other constraints, Allocation of failure and repair rates. Availability, Instantaneous, average uptime and steady state availability. Maintainability concepts. Good as new and bad as old concepts.

AML731 Applied Elasticity

4 credits (3-1-0)

Cartesian tensors, axioms, motion, stress, equations of motion, Piol, Kirchoff stress, finite strain measures, strain energy, small strains, linear elastic constitutive equations. Basic problems. General theorems of uniqueness. Superposition and reciprocity. St. Venant's problem. Plane problems. Principle of virtual work. Potential energy. Complementary energy. Reissner's variational principles. Approximate analytical and numerical methods of solution.

AML732 Solid Mechanics

3 credits (3-0-0)

Elementary theory of elasticity and plasticity. Theory of plates. Instability of rectangular plates. Stiffened plates. Anisotropic plates.

AML733 Dynamics

3 credits (3-0-0)

Single degree freedom system. Multidegree freedom system. Numerical methods. Holzer-type problem geared and branched systems. Euler's equation for beams. Torsional vibrations. Continuous systems. Lagrange's equations. Balancing of shaft. Self excited vibration.

AML734 Advanced Dynamics

4 credits (3-1-0)

Axioms, Hamilton's principles. Principle of virtual work. Lagrange's equations. Single degree of freedom systems. Multi-degree of freedom systems. Distributed parameter systems.

AML750 Modern Engineering Materials

3 credits (3-0-0)

Introduction, Structure- Property correlation: role of crystal structure, substructure and microstructure on properties.

High performance structural metallic alloys – Alloy steels, Selected Cu, Al, Ti, & Mg alloys and their applications. Advanced composite materials – Important reinforcements and matrix materials (metal, ceramics, polymer), micro mechanics of composites, role of interface, mechanical & thermal behavior, load transfer from matrix to fiber, nano structural composites.

Processing & characterization of composites - Forming and fabrication methods, testing and evaluation, strength, fracture and fatigue of composites.

Surface engineering of materials & their applications – Techniques for modification of surfaces for wear, corrosion and high temperature applications, typical structural applications.

Structure, property and processing of some new engineering materials, nanocrystalline materials, metallic foams, functionally graded materials, smart materials, shape memory materials.

Applications of materials to automobile and transport vehicles, Aerospace applications, materials for power generation, etc.

Materials for armament applications, marine environment and ocean structures, materials for other specialized applications.

AML751 Materials for Marine Vehicles

3 credits (3-0-0)

Corrosion. Selection of materials. Brittle fracture techniques. Introduction of fracture mechanics. Fatigue. Non-destructive testing.

AML771 Decision Theory and Design Optimization
3 credits (3-0-0)
Introduction to decision processes. Deter-ministic models. Probabilistic models. Decision-making undercertainty. Risk and certainty. Techniques of design optimization.

AMP772 Feasibility Study
3 credits (1-0-4)
This is a short project to be completed in one semester wherein a student will carry out a feasibility study for the manufacture of a given product.

AML773 Modelling & Analysis-I
3 credits (3-0-0)
Modelling and analysis in the context of design morphology, CAD and concurrent Engineering Analysis of stress, fluid flow and heat transfer.

Approximate, analytical and numerical methods for strength design: techniques of experimental stress analysis. Plastic behaviour, Limit design. Stress analysis of products made from composites.

Basic equations of fluid flow. Laminar flow through pipes. Transition and turbulence. Concept of boundary layer. Approximate methods. Similitude and modelling. Applications in product design.

AML774 Modelling & Analysis-II
3 credits (3-0-0)
Design of products subjected to vibration, Balancing, self excited vibrations. Modelling and analysis of heat transfer in products, thermal stresses, case studies.

Analysis of flow over bodies. Computation of forces. Flow through turbomachines. Design of flow metering and other fluid devices. Solid-fluid interaction problems in product design. Wind tunnel studies and applications to design.

AML775 Design Methods
3 credits (3-0-0)
Design problem and design process. Place of design activity in the production-consumption cycle. Design cycle including need analysis. Feasibility study, preliminary design, detailed design and planning for complete production-consumption cycle.

AMP776 Product Design Project I
3 credits (1-0-4)

AMP777 Product Design Project II
2 credits (0-0-4)
The above two courses would be run in successive semesters. The combined project work would comprise the following:

Application of systematic design procedure for the design of a chosen industrial product. Students are expected to carry out all the three phases of the design cycle including fabrication and testing. Lectures will deal with ergonomical factors in product design.

AML791 Ship Resistance & Propulsion
3 credits (3-0-0)
Similarity considerations and Model testing, Wave making resistance, Viscous resistance, Estimation of ship resistance, Appendage resistance, Presentation of resistance data and use of methodical series, Resistance of high speed and advanced marine vehicles.

Hull propeller interaction, Cavitation, Wave-wake interference, Thrust computations, Scale effect, Propeller design, Various propulsion devices, Ship standardisation trials.

AML792 Structural Design of Ships
3 credits (3-0-0)
Introduction, Ship as beam, long term loading of ship structure, Periodic wave loading, Longitudinal response & dynamic behaviour, Criteria of failure, Analysis of plates and grillages, Buckling of plates and panels, Recent advances in load definition, Transverse strength, Torsional strength, Bulkhead design, Design of special structures, structural design of unconventional crafts like hydrofoils, hovercrafts, SES, SWATH, Catamarans, trimarans etc., design of submarine structures, pressure hull, design of cylindrical shells, cones, bulkheads etc., Applications of computers to ship structures and structural optimization.

AML793 Ship Dynamics
3 credits (3-0-0)
Dynamics of oceans. Wave characteristics. Probabilistic theory of waves. Ship motions. Sea loads and bending moments. Limiting criteria stability and control of ships. Stabilization systems. Tests and trials.

AML794 Warship Design
3 credits (3-0-0)
Salient features of warships, merchantships, naval auxiliaries and yard-craft Principles and morphology of engineering design. Design spiral Feasibility studies. Preliminary design. Detailed design Warship design and production procedures. Staff requirements. Design activities. Drawing and specifications. Ship production tests and trials. General arrangement drawings—Weapon layout. Mass and space analysis. Stability aspects, Resistance, Propulsion. Sea keeping and manoeuvering considerations in design. Structural considerations. Survivability Cost aspects. Special types of hull forms. Computer aided ship design.

AML795 Submarine Design
3 credits (3-0-0)
Flotation and trim. Hydrostatics. Survivability. Surface unsinkability. Stability. Design of pressure proof structures. Design of school mounts of equipments. Resistance. Methods of drag reduction. Selection propulsion system. Endurance and indiscretion rates. Sea motions. Manoeuverability in vertical and horizontal planes and control surface design. Habitability. Ergonomics. Stealth systems. Submarine design procedures. System approach of submarine design and military economic analysis. Use of computers in submarine design. Outer hull lines development. Simulation of submarine in vertical plane.

AMS801 Independent Study
3 credits (0-3-0)

AMS802 Independent Study
3 credits (0-3-0)

AML803 Continuum Mechanics
3 credits (3-0-0)
Fundamental concepts. Thermo-dynamics of homogeneous processes. Equipresence. Kinematics. Field laws. Constitutive equations of simple materials. The isotropy group. Representative applications of solids, fluids and materials with fading memory.

AML805 Advanced Finite Element Methods
3 credits (3-0-0)
Automatic mesh generation techniques. Post-processing. Stress smoothing. Error analysis. P and H version. Adaptivity. Hierarchical formulations. Transition elements. Mixed formulations. FEM analysis of plates and shells. Parallel computing in FEM. Material and

geometric non-linearity. Mode superposition and direct integration techniques for dynamic problems.

AML811 Advanced Computational Fluid Dynamics
3 credits (3-0-0)
Transport equation in rotating reference frame, finite volume methods including higher order upwinding, grid generation, Galerkin & upwind finite element methods, considerations in discretization of turbulence models, rotating reference frame, hybrid methods, gridless methods, multigrid method, special topics chosen from phase change problem, two-phase flow, compressible flow and numerical simulation.

AMD811 Major Project Part-I
6 credits (0-0-12)

AML812 Turbulent Shear Flows
3 credits (3-0-0)
Origin of turbulence. Review of phenomenological theories. Structure of wall-turbulence and free-turbulence. Turbulent boundary layers. Plane and axisymmetric jets and wakes.

AMD812 Major Project Part-II
12 credits (0-0-24)

AMD813 Major Project Part-I
6 credits (0-0-12)

AML813 Impeller Pumps
3 credits (3-0-0)
Fundamental notations and classification of impeller pumps. Flow through impeller. Euler's equation, pressure and velocity distribution in impeller passages. Influence of finite number of blades, impulse and reaction types of impellers. Dynamic similarity. Impeller shapes. Blades with single curvature and double curvature.

Centrifugal pumps, single and multistage.

Mixed flow pumps, helical and diagonal pumps.

Propeller pumps, circular cascades.

Inlet and outlet systems. Cavitation and net-positive suction head considerations.

AMD814 Major Project Part-II
12 credits (0-0-24)

AML814 Fluid Transportation Systems
3 credits (3-0-0)
Mechanism of transportation of materials by fluid flow. Rheology and classification of complex mixtures. Fundamentals of two-phase flow. Phase separation and settling behaviour. Slurry pipeline transportation. Design methods. Terminal facilities. Pipe protection. Pneumatic conveying, pneumocapsule and hydrocapsule pipelines. Metrology associated with pipelines.

AML815 Hydrodynamic Stability
3 credits (3-0-0)
Formulation of hydrodynamic stability problems in various situations of flows, and particularly for parallel flows. Waves and allied experimental studies. Study of laminar to turbulent transition. Non- linear stability theories.

AML816 Compressible Fluid Flow and Gas Dynamics
3 credits (3-0-0)
Review of one-dimensional flows. Two-dimensional flows. Shocks and interactions. Small perturbation theory. Method of characteristics. Stock-boundary layer interaction. Viscous effects. Introduction to flows with chemical reactions. Dynamics of radiating gases. Hypersonic flows.

AML820 Advances in Fluid Engineering
3 credits (3-0-0)
A course on any advanced topic in the area of Fluid Engineering may be floated under this number.

AML821 Flow Induced Vibrations
3 credits (3-0-0)
General governing equations for solid-fluid interaction problems. De-coupling approximations.

Acoustically applied forces. Steady-state scatter, transient scatter and transient shock response.

Hydrodynamically applied forces Flow induced noise, dynamic divergence of compliant surfaces, flutter, stability of boundary layer on compliant surfaces, propeller induced forces.

Aeroelastic flutter of plates, linear and non-linear response. Flow induced vibrations of pipes and tube arrays etc.

AML831 Theory of Plates and Shells
3 credits (3-0-0)
Small deflections of transversely loaded plates. Plate equations, boundary conditions. Rectangular and circular plates with different support conditions. General equations of elastic shells in invariant form. Membrane theory. Moment theory. Rotationally symmetric shells. Shallow shell theory. Examples.

AML832 Applications of Theory of Plates and Shells
2 credits (2-0-0)
Introduction. Recapitulation of classical plate theory. Orthotropic plate bending. Simplified 4th order theory. Panels and grillages. Navier's and Levy's solutions. Stability. Bending of circular cylindrical shells. Stability of semi-infinite and finite cylinders. Donnel equations. Shells of revolution. Applications.

AML833 Applied Plasticity
3 credits (3-0-0)
Fundamentals of plasticity theory. Solution of elastoplastic problems. Theory and application of slip-line field. Bound theorems. Plastic anisotropy. Large deformations. Dynamic plasticity.

AML834 Structural Stability
3 credits (3-0-0)
Types of instability, static, dynamic and energy criterion of buckling. Imperfection sensitive structures. Applications to columns, beams, plates and shells. Follower forces, non-conservative loads.

AML835 Mechanics of Composite Materials
3 credits (3-0-0)
Composites, various reinforcement and matrix materials. Strength and stiffness properties. Effective module: spherical inclusions, cylindrical and lamellar systems. Laminates: Laminated plates. Analysis, strength and design with composites. Fibre reinforced pressure vessels. Dynamic, inelastic and non-linear effects. Technological applications.

AML836 Non-linear Vibration and Chaos
3 credits (3-0-0)
Prerequisite: AML701/AML734/CEL719/MEL733
Non-linear system. Analytical and graphical solutions. Solution stability and bifurcation. Fourier transforms. Poincare section. Temporal chaos in dissipative systems. Simple and strange attractors. Fractal dimension and geometric characterization. Hopf bifurcation and limit cycle. Sub-harmonic instability and periodic doubling.

AML837 Structural Mechanics
3 credits (3-0-0)
Matrix analysis of structures. Displacement methods. Substructuring grillages. Finite element methods for a

structural continuum. Element behaviour. Element families. Computational aspects of finite element methods.

AML838 Non-linear Mechanics
3 credits (3-0-0)
Singular points of non-linear systems. Phase plane and limit cycles. Non-linear conservative systems. Variational techniques for solving autonomous, resonant and non-resonant systems and asymptotic methods. Application to beams, plates and shells.

AML840 Advances in Solid Mechanics
3 credits (3-0-0)
An advanced course on any specialized topic in the area of Solid Mechanics may be given under this number. The course content will be announced by the teacher.

AML841 Advanced Theory of Elasticity
3 credits (3-0-0)
Two-dimensional problems in elasticity using complex variable techniques and conformal mapping. Three-dimensional problems. General representation theorems. Stability theory. Dynamics elasticity. Theory of rods.

AML851 Fracture Mechanics
3 credits (3-0-0)
Linear elastic fracture mechanics—Energy approach and stress intensity factor approach. General yielding fracture mechanics. Concept of crack opening displacement and J integral fracture criteria. Evaluation of fracture mechanics parameters. Fracture safe designing of structures and machine components. Service failure analysis.

AML852 Engineering Failure Analysis and Prevention
3 credits (3-0-0)
Common causes of failure. Principles of failure analysis. Fracture mechanics approach to failure problems. Techniques of failure analysis. Service failure mechanisms ductile and brittle fracture, fatigue fracture, wear failures, fretting failures, environment induced failures, high temp. failure. Faulty heat treatment and design failures, processing failures (forging, casting, machining etc.), failure problems in joints and weldments. Case studies for ferrous and non-ferrous metallic parts and parts made from polymers and ceramic.

AML854 Advances in Physical Metallurgy
3 credits (3-0-0)
Recent developments in phase transformations. Phase equilibrium in ternary alloys. Fracture resistant design.

AML855 Solid State Phase Transformations
3 credits (3-0-0)
Classification of solid state phase transformations. Nucleation and growth concepts. Spinodal decomposition. Specific transformations such as martensitic, polymorphic, re-crystallization, particle coarsening, etc. Crystallographic aspects of phase transformations.

AML856 Electron Metallography and Electron Diffraction
3 credits (3-0-0)
Interaction of electrons with matter electron optical systems. Term: Principles of electron diffraction, double diffraction. Fine structure of diffraction patterns. Theory of contrasts and applications to the study of imperfections and phase transformation. Techniques of specimen preparation.

Analysis of micrographs and diffraction patterns. SEM contrast in SEM and applications to the study of material problems. High voltage electron microscopy. TEM & STEM base methods of microdiffraction.

AML857 Quantitative Metallography
3 credits (3-0-0)
Introduction to probability theory. Geometric probabilities. Determination of volume, surface area, length, average size and number in volume. Particle size distribution. Coarsening of particles. Dislocation densities and strain measurements. Various applications of materials science and engineering.

AML871 Product Reliability and Maintenance
3 credits (3-0-0)
Definition of reliability, product pathology, reliability evaluation criteria, Stochastic and Markovian processes, product failure theories, reliability of parallel, standby and series products, reliability of non-maintained and maintained products. Use of signal flow graph theory for evaluating reliability. Reliability and reward. Making of more reliable products using less reliable components: “Good as New” and “Bad as Old” concepts. Maintenance policies. Information theoretic approach to reliability. Examples.

AML872 Optimization Techniques
3 credits (3-0-0)
Classical optimization techniques for unconstrained optimization. Kutur Tucker conditions. Sensitivity analysis for linear programming problems. Non-linear programming. Penalty function methods. Sequential linear programming. Feasible direction methods. Quadratic programming. Geometric programming. Integer programming. Application in enginee- ring design.

AML873 Design for Production
3 credits (3-0-0)
Basic concepts and goals of design for production. Processes, machines and tools for the manufacture of parts made from metals, ceramics and polymers. Significance of form in case of manufacture. Attainable tolerances. Industrial finishes like painting, polishing, anodising nickel and chrome painting, surface texturizing. Value analysis. Group technology. Assembly strategies. Design for quality.

AML874 Critical Product Evaluation
3 credits (3-0-0)
Value analysis. Quality standards in electronic, optical, mechanical and other products. Critically examining product literature, raising questions, filling gaps in information and discovering hidden details from product literature. Identifying areas of design action by identifying limitations in existing products and gaps in market segment. Examining an existing product for appreciation and detailing.

AML883 Properties and Selection of Engineering Materials
3 credits (3-0-0)
Properties and uses of ferrous and non-ferrous metals, ceramics and polymers in product design.

AMD897 Minor Project
4 credits (0-0-8)

AMD899 Design Project
10 credits (0-0-20)