## MARINE ENGINEERING

## B.Tech (NAVAL ARCHITECTURE AND MARINE ENGINEERING)

Effective Admitted Batch 2020-21

### *B. Tech -III Year- I Semester*

| Course code | Category | Course Title | Hours per week L | P | Internal Marks | External Marks | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| BT-1101 | BS | Maths – I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3101 | PC | Fluid Mechanics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3102 | PC | Ship Design - I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3103 | PC | Ship Construction | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3104 | PE | Professional Elective -I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3105 | OE | Open Elective-I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3106 | PC | Marine Thermal Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3107 | PC | Mechanics of Materials Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3108 | SC | Welding Practice | 1 | 2 | 50 | 50 | 100 | 2 |
| NM 3109 | INT | Internship-I | | | 50 | 50 | 100 | 2 |
| | | Total credits | | | | | | 22 |

### *B. Tech -III Year- II Semester*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 3201 | PC | Resistance and Propulsion | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3202 | PC | Strength of Ships | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3203 | PC | Ship Design - II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3204 | PE | Professional Elective -II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3205 | OE | Open Elective-II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3206 | PC Lab | Marine Hydrodynamics Lab | 0 | 3 | 30 | 70 | 100 | 1.5 |
| NM 3207 | PC Lab | Marine Instrumentation and Metrology lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3208 | PC Lab | Ship Drawing - III | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3209 | SC | Soft Skills | 1 | 2 | 50 | 50 | 100 | 2 |
| | | Total credits | | | | | | 21.5 |

### *B. Tech -IV Year- I Semester*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 4101 | PE | Professional Elective -III | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4102 | PE | Professional Elective -IV | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4103 | PE | Professional Elective -V | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4104 | OE | Open Elective-III | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4105 | OE | Open Elective-IV | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4106 | HSS | Elective - I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4107 | SC | Advanced NAPA Lab | 1 | 2 | 50 | 50 | 100 | 2 |
| NM 4108 | INT | Internship-II | | | 50 | 50 | 100 | 2 |
| | | Total credits | | | | | | 22 |

### *B. Tech -IV Year- II Semester*

| | | | | | | |
|---|---|---|---|---|---|---|
| NM 4201 | PROJ | Project work | 100 | 100 | 200 | 14 |
| | | Total credits | | | | 14 |

### Professional Electives

I. Intro to Offshore structures
II. Ocean Structures & materials
III. FEA
IV. Marine Manufacturing Technology
V. Fishing Vessel Technology
VI. Marine Hydrodynamics
VII. Advanced Welding Technology
VIII. sea keeping and maneuverability
IX. Dynamics of Offshore Structures
X. Design of Small Crafts
XI. Naval Vessels
XII. Advanced Ship Theory
XIII. Under Water Acoustics
XIV. Marine Engineering II
XV. Advanced Fluid Mechanics

### Open Electives

I. Industrial Electronics
II. NAPA /Rhino /Exact Flat Lab
III. Marine Instrumentation and Control
IV. Ship Vibrations
V. CASD
VI. Underwater Acoustics
VII. Ship Construction
VIII. Experimental Hydrodynamics
IX. Marine Power plant Engineering
X. Sub Sea Piping
XI. Marine Engineering I
XII. Hydrodynamics and computational Methods

### HSS Electives

I. Organization Behaviour

II. Industrial management and Entrepreneur

III. Operations Research

## NM 3101FLUID MECHANICS

***Course Objectives :***

This course offers basic knowledge on fluid statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

***Course Outcomes:***

The student will be able to:

* Identify importance of various fluid properties at rest and in transit.
* derive and apply general governing equations for various fluid flows
* Understand the concept of boundary layer theory and flow separation.
* Plot velocity and pressure profiles for any given fluid flow.
* evaluate the performance characteristics of hydraulic turbines and pumps

## SYLLABUS

## NM 3101– FLUID MECHANICS

Periods/week : 5. Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Properties of fluids- Viscosity- Pressure measurement and Manometers- Hydrostatic forces on surfaces.

Fluid Kinematics & Fluid Dynamics: Stream line- Stream tube- Stream function- Potential function- Classification of flows- Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity and circulation- Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy- Bernoulli's equation and its applications- Vortex motion- Free and forced vortices- Basic solutions of ideal fluid flows- Flow net analysis.

One dimensional Viscous Flow: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes- Laminar and turbulent regimes- Flow potential and flow resistance- Flow through branched pipes, Momentum equation- Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction, flow through porous media- Darcy's equation. Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations. Laminar Boundary Layer: Momentum integral equation- Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness.

Turbulent Boundary Layer: Laminar- Turbulent transition- Momentum equations and Reynold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.

Dimensional Analysis and Modeling Similitude: Fundamental and derived dimensions- Dimensionless groups- Buckingham p-theorem- Rayleigh method- Model testing- Types of similarity- Geometric, Kinematic and Dynamic similarities- Hydraulic diameter.

Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

*Text Book:*

Fluid Mechanics, by A.K.Mohanty, Prentice Hall of India Pvt.Ltd.

*References:*

1. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications.

2. Foundations of Fluid Mechanics, by Yuan, Prentice Hall of India.

3. Fluid Mechanics and its Applications, by S.K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

4. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, S.Chand & Co.

5. Fluid Mechanics by Kothandaraman and Rudramoorthy.

## NM 3102 SHIP DESIGN-I

***Course objectives:***

introducing basic ship theory, the ship design process, and systems engineering concepts. Hands on development of a computer code for ship hydrostatics analysis. Hands on experiments on ship stability and resistance. Visits and exercises on board ships. Individual ship design project and related workshops.

***Course outcome:***

This course gives an introduction to naval architecture, i.e. the engineering design of ships and other marine technology systems, and basic ship theory

such as hydrostatics, stability, resistance and propulsion. The objective is that students after finishing the course shall be able to:

* Demonstrate knowledge and understanding of the scientific basis and proven experience of ship design and insight into current research and development work;

* Demonstrate methodological knowledge and understanding in ship hydrostatics, stability, resistance and propulsion;

* Demonstrate ability to model, simulate, predict and evaluate ships' hydrostatics, stability, resistance, and energy and resource efficiency, even on the basis of limited information;

* Demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* Give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* Discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* Demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work;

* Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts.

## Syllabus

### NM 3102SHIP DESIGN - I

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

General Considerations and Introduction to Ship Design Methods: Marketing, manufacturing and operational considerations in Ship design. Technological, economic and sociological factors and national priorities. Ship design as a science and as an art. Owner's requirements, shipyard production facilities and operational constraints to be considered in the design process. Introduction to ship design method using basic ship or parent ship types, ship design as an iterative process and stages of ship design. The design spiral, design ship categories such as dead weight carriers, capacity carriers, and linear dimension ships. Displacement and volume estimation. Dead weight-displacement ratio, components of dead weight and displacement, determination of main dimensions and form coefficients, use of computers in ship design process.

Estimation of Weight And Volume Components, Design Of Hull Form And Determination Of Stability And Other Criteria:

Weight and capacity equations and their use in ship design. Use of cubic equation. Calculation of weight and volume components using parent ship data or other compiled data. Calculation of steel, wood, outfit and machinery weights, using formulas. Estimation of dead weight components, design of hull form from first principles. Sectional area curve. Design of load water line, sections, stem and stern profiles, other water lines and development of the lines plan., determination of position of the LCB. Preliminary estimation of power and propeller diameter. Preliminary check for rudder area. Use of series data such as BSRA series and Taylor's series. Calculation of stability, free board, trims capacity and tonnage. Stowage factors. Volume required for cargo fuel fresh water and Ballast.

Determination of Engine Power and Selection of Main and Auxiliary Machinery: Calculation of engine power. Relation between resistance and engine power. Criteria for selection of main propulsion plant. Types of main propulsion plants and fuels-their advantages and disadvantages. Different types of power transmission and shafting systems used in ships. Selection of propeller. Propeller types and number and estimation of main propeller parameters, such as diameter, rpm, number of blades, blade area ratio etc. Determination of location, area and volume of engine room. Estimation of size of engine casing. Estimation of electrical power requirement in the ship and deck area and volume required for installation of generators and main switchboard. Functions of various other auxiliary machinery such as boilers, cargo pumps, fuel and lube oil pumps, separators, cooling systems etc.

Cargo Systems and Cargo Handling Gear: Introduction to various types of cargo systems and cargo handling gear used on board ships such as cranes, derricks, Sampson posts, pumping systems etc. Properties and requirements for carriage of different types of cargo. General cargo carriers, light and heavy bulk cargo carriers and ore carriers. Unitised cargo- pallets, containers, barges, etc. and specialised ships for their carriage. Wheeled cargoes. RO-RO ships and ferries. Liquid cargoes-oil tankers liquefied gas carriers and chemical tankers. Selection of cargo handling gear-arrangements for general, bulk, unitised and liquid cargoes. Piping arrangement for tankers.

Important Design Features of Various Types of Ships and other Considerations: General cargo carriers, container ships, oil tankers, passenger vessels, bulk carriers, fishing trawlers, tugs, dredgers, barges, ferries. Different types of hull forms, propulsion systems, main and auxiliary machinery, cargo handling systems and operational requirements suitable of the above mentioned ships. Other consideration in ship design such as water tight integrity, damage stability, manoeuvring and sea keeping criteria, propulsive efficiency, minimisation of hull vibrations, compartments and super structure design in different types of ships. Trimming calculations in various

operating considerations. Ballasting arrangements and estimation of total ballast.

*Reference Books:*

1. Ship Design and Construction by R.Taggart
2. Basic Ship Theory, Vol.1 & 2 by K.J.Rawson and E.C.Tupper
3. Principles of Naval Architecture, Vol. 1,2&3 by Ed.V. Lewis

## NM 3103SHIP CONSTRUCTION

***Course Objective:***

* To be well versed in how to apply various knowledge of architecture on ship operations.

* To Understand Ship Stability and Statically Stability

***Course Outcome:***

* CO 01: To understand the types of Ships

* CO 02: To understand the Stress and Strain in Ships in Still water and in Sea way

* CO 03: To understand the principle part of Ships

* CO 04: To understand the advantages of welding over riveting

* CO 05: To understand the concept of law of floatation

* CO 06: To understand the center of buoyancy and factors affecting the same

* CO 07: To understand the Transverse Statically stability

* CO 08: To understand the Equilibrium of Ship

* CO 09: To calculate of List while Loading, Discharging and/or shifting weights, Correction of List

* CO 10: To understand how to use of hydrostatic tables and curves as supplied to ships, Displacement/draft-curve and table, Light displacement& Load displacement

## Syllabus

## NM 3103- SHIP CONSTRUCTION

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Introduction to ship building and materials used: A typical ship construction program. Building berth. Building Dock. Multi-stage construction methods. Equipment used in building berths. Use of Goliath cranes. Floating Docks. Ship types. Shipyard layout. Classification societies, development and application of classification rules, role of statutory bodies. Materials for ship construction. Structural steels, special steels, non- ferrous steels, non-metallic materials, material properties and testing of materials. Joining methods of materials, non-destructive testing.

Storage and preparation of material and structural elements: Material handling and storage, transport system in steel stockyard, material preparation Devices- cleaning, marking processes. The cutting process, Mechanical cutting, thermal Cutting, optically and numerically controlled cutting, bending of rolled and built-up sections, Plate bending. Nesting of plates.

Fabrication of sub-assemblies, units and hull erection:

Process of prefabrication, welding in prefabrication and erection stages, sub-assemblies, flat Sections, panels- flat and curved, double bottom sections, side tank units, fore-end and aftend Structures, deck and bulkhead structures. Assembly of hull-units. Erection of hull-units

On building berth/dock.

Ship structural components:

Functions and details of ship structural components, framing systems, single and double Bottom construction, shell and deck plating, bulkheads, pillars, girders and hatch-coaming,

Machinery casings, super structures and deck- houses. Bow and stern Structures. Bossing and Struts, bilge keels and fenders.

Out Fitting, Welding, Testing And Trials And Launching : q2 Various components of outfitting, consisting of systems, equipment and fittings of hull,

Machinery and electrical groups. Hull Preservation methods. Various outfitting methods.

Advanced outfitting. Methods of welding, metallurgy of welding weld defects, distortion and Stresses in welds, testing of welds. Inspection and testing during various stages of ship Construction. Testing of structures and tanks. Bollard tests and sea trials. Details of launching Arrangements.

*References:*

1. Merchant Ship Construction by D. A. Taylor
2. Ship Construction by D.J. Eyres
3. Ship Design and Construction by R.Taggart

## Syllabus

## NM 3104 - Industrial Electronics (OEC)

Periods/week: 4 Ses. : 30 Exam: 70
Examination Theory: 3hrs. Credits: 3

Devices: Semi-conductor diode, Zenor diode - Transistor - Silicon control rectifier. Rectifiers, Amplifiers, Oscillators, Cathode ray oscilloscope.

Industrial Applications: Poly-phase rectifiers - Control circuits - Motor speed control voltage control, Time delay relay circuits - Photo electric circuits.

Resistance welding, inducting heating - Dielectric heating.

Servomechanism: Open loop and closed loop systems (Elementary treatment only).

Introduction to Digital Electronics: Fundamentals of digital electronics, Number system and codes, Logic gates, Boolean algebra, Arithmetic - logic units, Flip-flops, Registers and counters, Memories: ROM, PROM, EPROM and RAM.

Introduction to Microprocessors: The Intel-8085 microprocessor; Architecture, Instruction set, Execution of instructions, Addressing structures, Timing and machine cycles of 8085 and programming I/O operations, Interrupts, Serial input and serial output, Programming the I/O ports, Programming the timer.

*Text Books:*

1. Industrial Electronics by Mithal (Khanna Publications).

2. Digital Computer Electronics - An Introduction to Micro Computer by Albert Paul Malvino, Tata McGraw-Hill Publishing Co. Ltd., New Delhi-2.

*References:*

1. Engineering Electronics by Ryder-McGraw Hill.

2. Micro Processors by Leventhal.

3. Industrial Electronics by Bhatacharya, Tata Mc-Graw Hill.

4. Industrial Electronics and Control by S.K. Bhatacharya and S. Chatarjee, 1995 Ed., Tata Mc-Graw Hill Pub. Co. Ltd.

## NM 3105 (A) INTRODUCTION TO OFFSHORE STRUCTURES

***Course Objectives:***

This subject introduces students to basic naval architectural knowledge e.g. naval architectural terms, ship components and simple hydrostatics calculations. It also enables students to familiarize themselves with various offshore engineering sectors including basic knowledge on types of offshore structures and their functions

***Course outcomes:***

On successful completion of this unit, students should be able to:

* Appreciate the shipbuilding industry

* Acquire the naval architectural principles and concepts

* Use the methods of numerical integration and quadrature

* Describe in detail a number of different offshore facility concepts, including the advantages and

* Disadvantages of each understand the various types of fixed and floating offshore platforms, including key design, fabrication

* And installation issues, as well as areas of applicability describe in detail a number of ships from recreational to naval, small to big, operating on or under the

* Sea acquire the basic knowledge of mooring systems and subsea technology

## NM 3105(A)

## INTRODUCTION TO OFFSHORE Structures

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. credits: 4

Fundamentals of physical oceanography, drilling technology, mooring systems, study of Environmental forces i.e. waves, wind, tides and current. Types of drilling rig suitability for particular applications. Drill ship- special equipment and operation of drilling rigs- supply crafts, structural arrangements, and semi-submersibles. Various types of offshore structures- jacket platforms, gravity platforms, complaint structures- guyed tower, tension leg platform etc. Structural systems used. Load calculation- wave, wind, current and functional loads, Soil structure interaction. Analysis of offshore structural components matrix methods-plane frame, grid and space frames. Introduction to dynamic analysis, transportation, launching and upending problems, preliminary design aspects of offshore structures. Safety and reliability of offshore structures.

*Reference books:*

1. Hydrodynamics of Offshore Structures by S.K.Chakravarthy

2. Offshore Structural Engineering by Thomas H.Dawson

3. Mechanics of Wave Forces on Offshore Structures by Turgut Sarpkaya & M. Isaacson.

## NM 3105 (B) FINITE ELEMENT ANALYSIS

***Course Objective:***

* To introduce the concepts of Mathematical Modeling of Engineering Problems.

* To appreciate the use of FEM to a range of Engineering Problems

***Course Outcomes:***

At the end of the course, a student will be able to

* CO1: apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence.

* CO2: analyze linear 1D problems like bars and trusses; 2D structural problems using CST element and analyse the axi-symmetric problems with triangular elements.

* CO3: write shape functions for 4 and 8 node quadrilateral, 6 node triangle elements and apply numerical integration to solve; 1D and 2D; stiffness integrations.

* CO4: solve linear 2D structural beams and frames problems; 1Dheat conduction and convection heat transfer problems.

* CO5: evaluate the Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity

## NM 3105 (B) FINITE ELEMENT ANALYSIS

Periods/week : 4 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Fundamental Concepts: Introduction, Historical background, Outline of presentation, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-Ritz method, Hamilton's principle. Galerkin's method, Saint Venant's principle.

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, in plane and Bending, problem modeling and boundary conditions.

Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical integration, Higher-order elements. Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

*Text Book:*

1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only).

*References:*

1. Introduction to Finite Element Method, by Abel & Desai.
2. Finite Element Method, by O.C. Zienkiewicz.
3. Concepts and Applications of Finite Element Analysis, by Robert D. Cook.
4. Introduction to Finite Element Method, by J.N.Reddy.

## NM 3106 Marine Thermal Lab

Periods/week : 3 Ses. : 50 Exam : 50
Examination Practical: 3hrs. Credits: 1.5

List of experiments to be conducted:

1. Determination of flash and fire points of oil samples - using Cleveland's apparatus

2. Determination of flash point of oil samples - using Abel's and Pensky-Martin's apparatus 3. Determination of Kinematic viscosity - using Redwood Viscometer – I & II, Saybolt's viscometer

4. Determination of calorific value of solid and liquid fuels using Bomb Calorimeter.

5. Aniline point test,

6. Calibration of pressure gauge - dead weight tester.

7. Volumetric efficiency of reciprocating air compressor.

8. Valve timing diagrams of IC engines(2 & 4 stroke engines).

9. Study of equipment to supplement theory, Boiler models,& I.C. Engine Components.

10. Experiments covering performance and other tests on Diesel Engines – Single cylinder, and Multi cylinder

11. Experiments covering performance and other tests on Petrol Engines

12. Refrigerating system and ice plant

13. Wind Tunnel

## NM 3107 – MECHANICS OF MATERIALS LAB

Periods/week : 3 Ses. : 50 Exam : 50
Examination Practical: 3hrs. Credits: 1.5

***List of Experiments:***

1. To study the stress strain characteristics (tension and compression) of metals by using UTM.

2. To study the stress strain characteristics of metals by using Hounsefield Tensometer.

3. Determination of compression strength of wood.

4. Determination of hardness using different hardness testing machines-Brinnels, Vickers and Rockwell's.

5. Impact test by using Izod and Charpy methods.

6. Deflection test on beams using UTM.

7. Tension shear test on M.S. Rods.

8. To find stiffness and modulus of rigidity by conducting compression tests on springs.

9. Torsion tests on circular shafts.

10. Bulking of sand.

11. Punch shear test, hardness test and compression test by using Hounsefield tensometer.

12. Sieve Analysis and determination of fineness number.

## NM 3108 (SC) Welding Practice

***LIST OF EXPERIMENTS:***

***(Practical/hands on)***

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Lap Joints)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Butt Joints)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(T-joint)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Flange Joints)

Study Experiments (Theoretical)

Spot welding and Spot Welding safety

TIG welding TIG welding safety.

Plasma welding and Plasma welding safety.

Submerged welding and Submerged welding safety.

## B. Tech -III Year- II Semester

## NM 3201 Resistance & Propulsion

***Course Objectives:***

Students undergoing this course are expected:

* To understand and analyze the gas turbine engine and its components.

* To realize and analyze the thermodynamics of various component of a gas turbine engine.

***Course Outcomes:***

* Apply the working concept of various types of gas turbine engines in practical applications

* Differentiate between a subsonic and a supersonic inlet and further relate it to aerospace applications.

* Analyze the working concept of various types of compressors.

* Illustrate the operational and designing concepts of gas turbine blades.

* Examine the suitability of the combustion chamber & nozzle for a given gas turbine engine

## NM 3201 - RESISTANCE AND PROPULSION

Periods/week : 4 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Introduction to resistance:Concept of resistance, flow of non-viscous and viscous fluids past submerged bodies and surface of ships. Introduction to important components of resistance such as frictional resistance, wave making resistance, eddy making resistance and air & wind resistance. Dimensional analysis, conditions of similarity, corresponding speeds of ship and model, Introduction to towing tank experiments and determination of ship resistance.

Viscous resistance and air & wind resistance: Froude's experiments with planks and plates, Reynold's experiments with pipes. Turbulence stimulation, friction lines, form resistance, boundary layer separation, effect of hull roughness, appendage drag, resistance in shallow water full scale tests and ship model correlation.

Wave resistance, estimation of total resistance and effective horsepower: Kelvin wave pattern, waves generated by ship, wave interference, Froude's method of resistance prediction. Resistance data presentation, estimation of total resistance and effective power, trail and service allowances. Aspects of hull form design. Statistical analysis of resistance data by regression.

Propeller Design and hull propeller interaction: Screw propeller terminology and geometry. Dimensional analysis and conditions of similarity. Propeller in open water. Propeller coefficients, hull- propeller interaction, wake and thrust deduction, hull efficiency, relative rotative efficiency, propulsive coefficient. Cavitation, fully cavitating propellers. Propeller design using methodical series data, design of free running propellers, propellers for tugs and trawlers. Elementary treatment including basic principles of momentum theory, blade element theory, lifting line theory and lifting surface theory of propeller. Design of propellers for a variable wake.

Ship Propulsion devices, prediction of ship's power and strength of propellers: Ship Propulsion devices and their historical development, water jet propulsion, controllable pitch propellers, vertical axis propellers, shrouded propellers, tandem and contra-rotating propellers and paddle-wheels, super conducting electric propulsion. Model propulsion experiments in towing tanks and Cavitation tunnels. Ship trails and service performance analysis, estimation of power based on model experiments and propeller design charts,

use of Br- d charts, Kt- Kq- J diagrams. Propeller blade strength methods of calculation, classification society rules, Propeller materials.

*Reference Books:*


1. Principles of Naval Architecture, Vol. II by Ed.V.Lewis.
2. Resistance and Propulsion of Ships by S.A.Harvald.
3. Marine Propellers and Propulsion by J.C.Carlton.


## NM 3202STRENGTH OF SHIPS

***Course objective:***

The course objective is to provide students with the knowledge and application skills to meet the knowledge, understanding, and practical assessment requirements for ship construction and stability as part of the requirements for an officer in charge of the navigational watch.

***Course Outcomes:***

* Determine whether stresses on the ship are within the permitted limits by use of stress data

* Understand the fundamental actions to take in the event of partial loss of intact buoyancy

* Demonstrate knowledge of the fundamental actions to be taken in the event of partial loss of intact buoyancy

* Use tables and diagrams of ship stability and trim data to calculate the ship's initial stability, drafts, and trim for any given disposition of cargo and other weights

* Demonstrate knowledge of principal structural members of a ship and the proper names for various parts

## NM 3202 : STRENGTH OF SHIPS

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Introduction to functions and analysis of ship structures: Functions of ship structure, the forces acting up on a ship at sea, static forces, dynamic forces. The distortion of ship's structure. Application of theory and experience. Limitations of the theory. Distinction between strength and stiffness of hull girder. Forces and moments acting on ship's structures in regular waves in head seas, and oblique seas. Nature of stresses in ship's hull when ship is floating in still water and on a wave. Modeling of ship's' structures including general remarks on structural strength. Three-dimensional analysis of a ship structures (elementary treatment only). Assumptions and simplification of longitudinal strength calculations. Introduction to the use of probability theory in the assessment of longitudinal strength.

Longitudinal strength of hull girder and ultimate strength: Modeling of ship hull Girder as a beam. Assumed form of wave systems. Conditions of Hogging and Sagging. The buoyancy curve. The weight curve. Distributions of dead weight items. The Load, shearing force and bending moment curves. Characteristics of shear force and bending moment curves. Still water bending moment, wave bending moment and total bending moment. Bending theory applied to ship structures and its limitations. Calculations of hull girder section modulus and hull deflection. Dynamic effects on loads acting on the hull due to ship motions and wave action such as slamming. Thermal effects on hull girder. Stresses in the inclined condition. Application of plastic theory to ship structures, stress-strain diagram, calculation of plastic neutral axis and plastic moment. Ultimate strength of a simply supported beam and a fixed ended beam. Ultimate longitudinal strength of a ship.

Transverse strength of hull girder and ship hull material: Transverse loads on ship's hull such as hydrostatic loads, weights, wave loads, racking, and torsion. Effect of hatches and other openings. Strain energy method, moment distribution method and comparison of the two methods, Influence of bracketed connections. Manufacture of steel. Requirement of ship building quality steels, high strength steels, Aluminum alloys and glass reinforced plastics.

Mechanical properties and chemical composition of structural materials: Testing of steels such as tensile test bend test and impact test. Brittle fracture. Steels for very low temperature applications.

Strength of bulk heads, decks and tank tops, foundations, super structure, deck houses and structural discontinuities and local strength problem: Types of bulkheads and loads on bulkheads. Strength analysis of bulkheads. Types of foundations- loads on foundations and Strength analysis. Generation of loads on superstructure. Factors affecting superstructure efficiency. Effective superstructure. Strength of Aluminum alloy superstructure. Strength analysis of decks and tank tops. Determination of scantlings of superstructure decks on the basis of simple bending theory. Strength of deckhouses, structural discontinuities such as holes in plates, notches in beams and girders, deck openings, ends of superstructure, ends of girders and other structural members. Stress concentration due to various structural discontinuities mentioned above. Applications of three-moment theorem to ship structures. Use of strain energy method for solution of bending moment problems and redundant structural problems.

Theory of thin plates, buckling of structures, composite construction, grillage analysis, calculation of scantlings as per rules: Thin plate theory and solution for different boundary conditions. Application of plain stress theory to ship structural problems. Case of a plate acted upon by a concentrated load; Buckling of plates. Influence of stiffeners (longitudinal and \ or transverse) on the buckling stress of ship's plating. Bending and membrane stresses in plates (application to bulkheads, shell plates etc.) Composite construction-

Two materials with same elastic modulus. Two materials of different elastic Modulii. Bending of composite beam. Introduction to Grillage. Analysis of simple Grillage.

Scantling calculations according to the rules of classification societies.

*Reference books:*

1. Ship Construction by D.J.Eyres Merchant Ship Construction by D.A.Taylor

2. Principles of Naval Architecture, Vol. II by Ed.V. Lewis.

## NM 3203 SHIP DESIGN – II

***Course objectives:***

Introducing basic ship theory, the ship design process, and systems engineering concepts. Hands on development of a computer code for ship hydrostatics analysis. Hands on experiments on ship stability and resistance. Visits and exercises on board ships. Individual ship design project and related workshops.

***Course outcome:***

This course gives an introduction to naval architecture, i.e. the engineering design of ships and other marine technology systems, and basic ship theory such as hydrostatics, stability, resistance and propulsion. The objective is that students after finishing the course shall be able to:

* Demonstrate knowledge and understanding of the scientific basis and proven experience of ship design and insight into current research and development work;

* Demonstrate methodological knowledge and understanding in ship hydrostatics, stability, resistance and propulsion;

* Demonstrate ability to model, simulate, predict and evaluate ships' hydrostatics, stability, resistance, and energy and resource efficiency, even on the basis of limited information;

* Demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* Give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* Discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* Demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work;

* Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts

## NM 3203 SHIP DESIGN – II

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

General Arrangements of Ships: General arrangement of ships. Layout of main and other decks. Water tight subdivision of the ship's hull. Disposition of bulk heads and decks. Allocation of cargo and machinery spaces. Bridge and navigation spaces. Arrangements of tanks for fuel oil, ballast water and other liquids. Engine room layout. Cargo handling arrangement, requirement for ships. Accommodation in ships. Design philosophy of accommodation spaces. Living spaces, commissionery spaces, spaces for dining, recreation and services. Access diagrams. Design of super structure and layout. General arrangement and deck layout of general cargo ship, bulk carrier, oil tanker, container ship, passenger ship, fishing trawler, ferry, tug and dredger.

Hull Fittings, Navigational aids and lifesaving appliances: Closing devices, water tight, weather tight, gas tight and non-water tight floors. Windows and portholes. Bulkhead openings, hull openings, cargo port, bow doors, stern ramps. Man holes and access doors.

Hatch covers-weather deck and between deck. Types of hatch covers-sliding, rolling and pontoon. Operating mechanisms. Arrangements for ensuring water tightness. Lifesavingequipment primary and secondary types and ship requirements. Navigational equipment. Bulwarks railings and awnings, gangway, gangplanks, and gangway adders. Masts and rigging, mast designs.

Auxiliary machinery and other Ship Systems: Ship auxiliaries and equipment. Functions of auxiliary machinery and design requirements for location and installation. Selection of components and space allocation for ship systems including electrical system, Fuel and lubricating oil systems. Fresh water and sea water systems, Air conditioning, ventilation, and refrigeration systems, anchoring and mooring gear,

Steering gear types and location, automation of ship systems and ship operation. Unmanned machinery spaces.

International and National regulatory Bodies: Safety and habitability. Impact of the regulatory bodies in ship design, IMO and classification societies, SOLAS, ILLC, ITTC, MMD. Prevention of marine pollution-MARPOL regulations. Free board assignment. Stability in various operating conditions, important features of maritime law of India -regulations regarding a/c, ventilation, noise, vibrations. Survival after damage. Carriage of dangerous goods. Collision prevention.

Ship design organisation and design consideration for special ships and use of computers: Evolution of design philosophy. Changes effected over the years. The “Titatanic Disaster” and impact.

Design features of special types of ships- ice breakers, refrigerated cargo carriers, liquefied gas carriers, aircraft carriers, Ro-RO vessels, SWATH vessels, luxury passenger ships and high speed ships.

Double hull structures for tankers. Hatch coverless containers. Offshore supply vessels, deep sea fishing vessels, use of computers in design of general arrangement and systems. Trends of future developments. Aesthetic considerations in ship design.

*Reference Books:*

1. Ship Design and Construction by R.Taggart

2. Principles of Naval Architecture, Vol. 1,2&3 by Ed.V. Lewis

## NM 3204 (A) : MARINE MANUFACTURING TECHNOLOGY

***Course outcome:***

Introduce students to theory and operation of manufacturing including manufacturing processes and equipment overview, manufacturing design, production process and flow, materials, machine operations and logistics.

***Course objective:***

* Identify the different stages of a manufacturing process.

* Interpret the elements of the product design process.

* Identify the common machines used in a manufacturing process.

* Explain the operations and capabilities of machines used in manufacturing.

* Determine the operations used in finishing manufactured products.

* Explain the operations and capabilities of automated machines used in manufacturing.

* Interpret the functionality of base lining and documentation in a manufacturing process.

* Determine the main elements of quality assurance in a process.

* Identify characteristics of end product logistics.

## NM 3204(A) : MARINE MANUFACTURING TECHNOLOGY

Periods/week: 5 Ses : 30 Exam: 70
Examination Theory: 3hrs. Credits: 4

Foundry: Foundry tools and appliances, layout – pattern types, materials, allowances, pattern making, moulding sands, types. Moulding methods, equipment for moulding, casting methods.

Lathe: Working principle, classification, specification, different operations on a lathe, methods of taper turning, cutting speed, feed, depth of cut, machining time and power required for cutting. Turret and capstan lathes.

Shaper and Planer (Elementary Treatment only): Principal parts, classification – quick return mechanisms, table feed mechanism working on shaper and planer, a comparison. Work holding devices.

Drilling and Boring Machines (Elementary Treatment only): Classification, specifications, cutting speed, feed, machining times, parts and description of boring machines, types.

Power Press: Operation, components, classification, selection, cutting dies, power requirements, power press operations, punching, blanking, deep drawing.

Linear and angular measurements: Micrometers, Slip gauges, Vernier and optical bevel Protractors, sine bar Angle gauges.

Comparators: Types, Mechanical, Electrical, Electronic comparators. Measurement of Straightness- flatness- square ness and symmetry- parallelism and circularity.

Metrology: Metrology of screw threads and Metrology of gears (Measurement of Pitch and tooth thickness only).

Grinding: Introduction-abrasives-grinding wheels, bonding processes, selection of grinding wheels-grinding machines-classification-honing-lapping, super-finishing, buffing, polishing, selection of process parameters.

*Text Books:*

1. Engineering Metrology by R.K. Jain

2. Production Technology by R.K. Jain and S.C. Gupta

*References:*

1. Production Technology by P.C. Sharma

2. Workshop Technology, Vol.1, 2&3 by W.A.J. Chapman

3. Machine Tools by Bhattacharya

## NM 3204(B) : FISHING VESSELS TECHNOLOGY

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Importance of fishing, Classification of fish for harvesting. Fishing methods- Purse seining, Drift netting, Gillnet fishing, Long line fishing. Pole and line fishing, Trawling, Harpooning.

Fishing Gear- Towed gear, Bottom trawling, side trawling, Towing arrangements, stern trawling operations and equipment, multiring trawling, Midwater trawling, Purse seining Types, Analysis of fishing nets.

Storing and preservation of fish on board a vessel, Fish hold arrangement. Insulation, icing and freezing. Refrigeration machinery.

Design of fishing vessels. Side trawlers, stern trawlers, purse seining. General arrangement, Layout and equipment on deck. Determination of main dimensions. Estimation of component weights. Development of lines. Estimation of resistance. Design of propellers for trawlers. Machinery- main and auxiliary, Electrical systems, structural arrangements. Materials for the construction of fishing vessels.

Economics of fishing vessels. Estimation of initial and operation costs. The influences of size, speed, power, selling price, distance optimised fishing vessel design. Design and economics of simple low cost country fishing crafts.

*References Books:*

1. Design of Small Fishing Vessels by John Fyson

2. Fishing Boats of the World by Jan-Olof Traung

## NM 3205(OE) : NAPA /RHINO /EXACT FLAT LAB

## NM 3206 : MARINE HYDRODYNAMICS LAB

Periods/week :3 Ses. : 50 Exam : 50

Examination Practical: 3hrs. Credits: 1.5

Experiments covering the following aspects:

* Pressure, Velocity and flow rate measurements,

* Calibration of Venturimeter.

* Reynolds number of steady pipe flow.

* Calibration of small orifices and mouth pieces.

* Calibration of orifice meters and flow nozzles.

* Vortex motion on the aft portion of blunt bodies.

* Pressure distribution around aerofoil sections.

* Determination of metacentric height of a floating model.

* Visits to Model testing tank to do ship model testing and understand basic facilities.

## NM 3207 : MARINE INSTRUMENTATION AND METROLOGY LAB

Periods/week: 3 Ses. : 50 Exam: 50

Examination Practical: 3hrs Credits: 1.5

Metrology experiments

* Calibration of mechanical comparator

* Calibration of Micrometer

* Testing of Concentricity trueness and parallelism of a mandrel

* Measurements of taper bar using Dial gauge, bevel protractor and sine bar.

* Distance between two holes of a template using Vernier height gauge.

* Measuring the central height of a circular spigot

* Measuring the pitch diameter, diametral pitch and pressure angle of an involute spur gear

* Study of flatness of slip gauges using optical flats and monochromatic light.

* Calibration of Vernier calipers.

* Calibration of Vernier Height gauge

***Instrumentation experiments***

* Calibration of thermocouple, thermisiters.

* Calibration of force and stresses using strain gauges.

* Flow rate measurement and roto meter.

* Calibration of pressure gauge.

## NM 3208 : SHIP DRAWING – III

Periods/week : 3 Ses : 50 Exam : 50

Examination Theory: 3hrs. Credits: 1.5

Theory (Stability and trim) Transverse and longitudinal stability and trim calculations, effects of movement of liquids, cargo, fuel, fresh water, grain, rules for stability. Calculations and plotting of cross curves, G-Z curves. Stability booklet for ships, DWT scale, cargo loading and unloading, Ballasting and de-ballasting. Inclining equipment, Calculation and estimation of GM in different service conditions. Weight calculations. Introduction and importance of weight calculations in ship design and construction. Calculation of weights of plates and sections, weight calculation data. Detailed estimation of steel weight of ship's hull. Calculation of LCG and VCG of ship and off centre line moments of ship. Calculation of total weight of the ship based on group weights. Calculation of centroid of sections and plates and other structural elements.

Practical: Drawing of Stability Curves, Analysis of inclining experiment and weight calculations, LCG and VCG calculation

## NM 3209 (SC) Soft Skills

***Course Objectives:***

1. To develop skills to communicate clearly.
2. To aid students in building interpersonal skills.
3. To enhance team building and time management skills.

4. To inculcate active listening and responding skills.

***Course Outcomes:***

1. Make use of techniques for self-awareness and self-development.

2. Apply the conceptual understanding of communication into everyday practice.

3. Understand the importance of teamwork and group discussions skills.

4. Develop time management and stress management.

## SYLLABUS

Introduction to Soft Skills: Communication – Verbal and Non Verbal Communication - Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, Just a Minute (JAM) sessions, Adaptability.

Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

*Reference Books:*

1. Krannich, Caryl, and Krannich, Ronald L. Nail the Resume! Great Tips for Creating Dynamite Resumes. United States, Impact Publications, 2005.

2. Hasson, Gill. Brilliant Communication Skills. Great Britain: Pearson Education, 2012

3. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Education, 2001.

4. Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.

5. Rizvi, Ashraf M. Effective Technical Communication: India, McGraw-Hill Education. 2010

6. Thorpe, Edgar &Showick Thorpe. Winning at Interviews. 2nd Edition. Delhi: Dorling Kindersley, 2006.

## B. Tech -IV Year- I Semester

## NM 4101 (A) MARINE HYDRODYNAMICS

***Course Objectives:***

To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

***Course Outcomes:***

Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

## NM 4101 (A) MARINE HYDRODYNAMICS

Periods/week: 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Small Amplitude Wave Theory Formulation and Solution: Review of hydrodynamics-Boundary Value Problems, summary of two-dimensional periodic water wave BVP, solution of linearized water wave BVP for a horizontal bottom, dispersion equation, engineering wave properties-water particle, kinematics of progressive waves, pressure field under a standard wave, partial standing waves, energy and energy propagation in progressive waves- principle of conservation of energy. Energy Flux.

Wave Forecasting: Generation of waves-theories of wave generation by Kelvin, Phillips, Milne, Jeffrey, Swerdrup and munk. Concept of fully developed sea, Characteristics of ocean waves, significant wave height and period, wave height variability, energy spectra of waves, simplified wave prediction models-SMB and PNJ. Methods, wave forecasting charts, effects of moving storms and variable wind speed and direction.

Wave Transformation and Wave statistics: Transformation of wave entering shallow water, shoaling of waves in shallow water, wave reflection, refraction and diffraction, combined refraction, diffraction, and wave breaking. Wave Height distribution-single wave train, wave groups, narrow banded spectra, Rayleigh's distribution, wave spectrum, directional wave spectrum-JONSWAP, PNJ and Bretschneider spectra.

Wave Forces: Wave forces on vertical cylindrical bodies due to non-breaking waves – Basic concepts, calculations of forces and moments, Transverse forces due to eddy shedding (Lift forces), selection of hydrodynamic force coefficient, $C_d$ and $C_m$, calculation of forces and moments on groups of vertical and non-vertical cylindrical bodies due to breaking and non-breaking waves.

*Text Book:*

1. Shore Protection Manual, Vols. 1 & 2 by US army coastal engineering research center publication

*Reference Books:*

1. Water Wave Mechanics by Dean and Dlrymple
2. An introduction to Hydrodynamics and Water Waves by B. Le Mehaute
3. Estuary and Coastline Hydrodynamics by A.T. Ippen

## NM 4101 (B) ADVANCED WELDING TECHNOLOGY

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Introduction: Classification of welding and related processes. General conditions for welding, edge preparations, and design of welded joints, welding codes and symbols, weldability of metals and metallurgy in welding.

Plastic Welding: Forge Welding: Types, Forged joints etc. Resistance Welding: Principle, types, spot, seam, etc. Thermit welding.

Gas Welding: Principle, equipment, different gas flames, gas welding techniques, types of gas welding, oxy-acetylene, air-acetylene, and oxy-hydrogen welding etc.

Arc Welding: Principle and theory. Arc welding equipment, arc welding current and voltage, polarity of electrodes, angularity of electrodes, precautions in arc welding. Arc welding types, Carbon arc, metal arc, MIG, TIG etc.

Solid State Welding: Principle and types. Latest welding techniques, electron beam, laser beam, metal flame spraying etc. Under water welding (elementary treatment only). Related processes, oxy-acetylene cutting, arc cutting, brazing, soldering etc.

Welding of various Metals: Cast Iron, steel, non-ferrous metals, etc. Welding defects, inspection and testing-design for welding. Safety practices and training in welding and welding machines (elementary treatment).

*Text Books:*

1. Welding Engineering by R.L. Agrawal and Tahil Manghnani
2. A Text book of Welding Technology by O.P. Khanna
3. Welding Technology by N.K. Srinivasan

*References:*

1. Welding Engineering and Technology by R.S. Parmar
2. Welding and Welding Technology by Richard L. Little
3. Welding by A.C. Davies
4. Production Technology by R.K. Jain and S.C. Gupta
5. Elements of Workshop Technology, Vol.1 by S.K. Hajra Choudury
6. Welder Trade Theory by S.K. Singh

## NM 4102(A) SEA KEEPING AND MANEUVERABILITY

***Course outcomes:***

* Apply the concepts of Static Equilibrium and Archimedes' Principle to the operation of a ship.

* Demonstrate the ability to assess the stability condition of a ship. Predict the effect of planned shipboard evolutions on ship stability.

* Understand the significance of damage to a ship which has compromised its watertight integrity. Use hydrostatics to make intelligent and safe choices to maintain a ship afloat and upright.

* Understand the structural arrangement of a ship, including the choice of materials and the stresses developed by loads encountered in its operating environment.

* Understand the different components that make up a ship's resistance and the manner in which the propulsion plant transmits its power to overcome those forces.

* Understand factors affecting the seakeeping and maneuverability of ships in a seaway.

***Course objective:***

This course is an introduction to the applied science of ship systems. The course describes ships and submarines and how they remain afloat from a design and application perspective. Included are topics in hydrostatics, ship stability and operability, materials, fluid dynamics and propulsion.

## NM 4102(A) : SEA KEEPING AND MANOEUVRABILITY

Periods/week : 5. Ses. : 30 Exam : 70
Examination Theory : 3hrs. Credits: 4

Introduction to sea keeping: Importance of sea keepinganalysis. Behaviour of a ship in a seaway. Regular waves, Sinusoidal and trochoidal Theories. Chacteristics of waves; Sea surface. Analytical and statistical representations. Descriptive characterisation of the sea. Average and significant wave heights. Wave histogram. Characterisation by energy spectrum. Standard sea spectra. Beaufort scale.

Ship motions in regular waves: Surge, sway, heave, roll, pitch and yaw. Coupled and uncoupled motions. Equations of motion, inertial, damping, restoring and exciting forces and moments. Determination of the forces and moments. Tuning factor and Magnification factor. Added mass. Coupled heaving and pitching. Motions in shallow water.

Ship Motions in Irregular waves:Encounter spectrum. Response amplitude operators and their calculation by theory and experiment. Motion spectrum and statistical characteristics of motions in irregular waves.

Dynamic effects: Relative bow motion. Deck wetness and slamming. Added Resistance in waves. Added power. Power increase due to wind and waves. Loss of speed in a seaway. Loads due to motion. Wave loading and bending moments. Vertical and Rolling effects. Sea sickness

Stabilization of ship motions: Roll stabilizers- Bilge keels, Gyroscopic stabilizers, Movement of weight, Rudder action, Jet flaps, Stabilizing fins, Passive and Active tank stabilisers.

Pitch stabilization methods: Ship motion experiments. Generation of Regular and Irregular waves. Captive and free running model tests. Full scale Tests.Design considerations for sea keeping. Seakeeping criteria. ITTC Guidelines. Effect of design parameters and hull form on seakeeping.

Introduction to Manoeuvrability: Controlled and uncontrolled motions. Control Loop. Course keeping. Motion stability of ocean vehicles. Equations of motion. Hydrodynamic derivations. Stability criterion. Course changing. Tuning circle, zigzag and spiral manoeuvers. Heel while turning. Manoeuvering trials.

Control Surfaces: Control surface geometry. Rudders- types and characteristics. Effect of stall, aeration and cavitation.(Flow around rudder,Influence of ship- features on controls fired stability.) Design of rudders. Calculation of steering gear torque. Bending moment and stresses in rudder stock. Structural design of rudders. Other maneuvering devices. Maneuvering in restricted waters. Squat in shallow water. Bank suction effects- Interaction between ships. Theoretical determination of hydrodynamic derivatives of ship and control surfaces. Experimental determination of hydrodynamic derivatives. Estimation of maneuvering characteristics form hydrodynamic derivatives.

*References:*

1. Dynamics of Marine Vehicles by Rameshwar Bhattacharya.

2. Principles of Naval Architecture, Vol. III by Ed.V. Lewis

## NM 4102(B)– Dynamics of Offshore Structure

Periods/week : 4 Ses. : 30 Exam : 70
Examination theory: 3hrs. Credits: 3 Module 1 h A

Dynamic perspective. Introduction to different types of ocean structures. Development of structural forms for deep and ultra deep waters. Basis of structural design of ocean structures. Environmental forces. Structural dynamics. Basics-SDOF systems Fundamentals of structural dynamics. Mathematical modelling of structural systems. Single Degree of Freedom (SDOF) systems. Characteristics of sing degree of freedom model – formulation of equation of motion. Free and Forced vibration of single degree of freedom systems. Undamped and damped systems.

Structures in the offshore environment - Description of typical offshore structures – Fixed- Compliant Floating - Solid fluid interaction parameters - Spring factor - Added mass and damping Response of offshore structures - Modelling of offshore structures – single and multi-degree freedom systems – effect of foundations

Structural action of ocean structures - Multi-Degree of freedom (MDOF) systems. Formulation of equation of motion - Influence coefficients - Eigen value problems. Dynamic matrix method. Dunkerley's method - Matrix iteration method - Stodla's method.Mode superposition. Mode truncation.Rayleigh-Ritz method.Damping.Rayleigh damping – Caughey damping. Application of dynamics. Fluid structure interaction (FSI).Perforated members. Articulated tower (AT).Freely moving structures - Stability of submerged and floating structures - Stability at small and large angles

Experimental Structural Dynamics. Experimental studies-free floating studies-free decay studies. Experimental investigation on perforated cylinders & perforated TLP model. Structural dynamics, introduction to stochastic dynamics of ocean structures. Motion analysis in random waves - Low frequency oscillation. Dynamic positioning.

Stochastic Dynamics – Introduction to Stochastic Dynamics of ocean structures. Fatigue Prediction. Random Environmental Processes – Response Spectrum.

*References*

1. Wilson, J. F., Dynamics of Offshore Structures, John Wiley, 2002.

2. Clauss, G, Lehmann, E &Ostergaard, C., Offshore structures - Vols 1 & 2, SpringerVerlag, 1992. 3. Chakraborti, S. K., Non Linear methods in Offshore Engineering, Elsevier SciencePubl, .2002. 4. Hooft, J. P., Advanced Dynamics of Marine Vehicles, John Wiley, 1982.

## NM 4103(A) : DESIGN OF SMALL CRAFTS

***Course objectives:***

provides a broad overview of craft design, construction and operation. The craft design process may be broken down broadly into two stages: Conceptual and/or preliminary design. The preliminary design process will normally take the form of a techno-economic appraisal, using a fundamental engineering economy approach.

***Course outcome:***

* demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work

## NM 4103(A) DESIGN OF SMALL CRAFTS

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Tugs and towing vessels: Types, stability requirements, Bollard pull, powering, Features of tow hook, Equipment. General arrangement, Special features of pusher tugs, Kort-nozzle, Voith-Schneider and Schottel propulsion in tugs. Design aspects.

Dredgers: Types of dredgers, Hydrostatics and stability considerations. Powering and dredging machinery and equipment. Disposal of dredged material. Design considerations.

High speed crafts: Their role in offshore and naval operations. Special features. Design considerations

Fishing vessels: Types of fishing vessels and fishing methods. Special features. Stability requirements and IMCO recommendations. General arrangement. Fishing gear and equipment. Preservation and processing of catch and by-products. Fishing vessel design.

*Text Books:*

1. Principles of Naval Architecture by Ed.V. Lewis

## NM 4103(B) : NAVAL VESSELS

Periods/week : 4 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits : 3

Historical development of different types of naval vessels: Distinguishing features of warship types. Indigenous design and production of naval vessels. Mission requirements and constraints. Concept exploration and development of warship criteria. Determination of main dimensions. Volumes based and weight based criteria. Space allocation and general arrangement.

Design of Hull Form: Warship resistance data, Hydrodynamics of naval vessels. Propellers for warships. Design and construction. Propeller data for heavily loaded propellers. Hydrodynamic design methods. Stability criteria for warships. Damage survival considerations.

Main and auxiliary machinery in warships: Comparative methods of steam, diesel and gas turbine plants. Combined plants. Requirements of sea keeping and stability platform. Stabilisation systems. Special manoeuvring requirements for naval vessels.

Structural arrangements in naval ships: Structural design criteria and design procedures. Shock and methods to reduce its effects. Accommodation. Habitability standards. A/C requirements. Nuclear, bacteriological and chemical defense arrangements. Weapon systems. Guns torpedoes, depth chargers, mines and missiles. Radar and Sonar weapon control systems. Counter Measures.

Detailed study of some modern naval ships: Submarine: General description, pressure hull external structure, diving and surfacing systems. A/C and ventilation systems. Stability, equilibrium polygon. Distance when submerged and while on surface. Propulsion system. Rudder and hydroplanes. Nuclear submarines.

## NM 4104(A) MARINE INSTRUMENTATION AND CONTROL

Periods/week : 4 Ses. : 30 Exam : 70
Examination theory: 3hrs. Credits: 3

Instrumentation: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement. Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

*Text Books:*

1. Automatic Control Systems, by Benjamin C. Kuo.

2. Mechanical Measurements, by R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

*References:*

1. Experimental Methods for Engineers, by J.P.Holman, McGraw-Hill.

2. Instrumentation for Engineering Measurements, by R.H. Cerni and L.E. Foster, J.Wiley & Sons, New York.

3. Mechanical and Industrial Measurement, by R.K.Jain, Khanna publishers, Delhi.

4. Control Systems Engineering by Nagrath/Gopal ,New age international.

## NM4104(B) : SHIP STRUCTURAL DESIGN AND VIBRATION:

***Course objective:***

Presentation of the basic notions of the vibration theory and ship vibration. Definition of vibration problems and consideration of possibilities for their solutions. Reliable prediction of vibration level in the ship design stage. Review of vibration measurement procedures and vibration remedy

***Course outcomes:***

Upon completion of the course, students will be able to:

* understand basic principles of ship vibration.

* prepare input data for global hull-girder ship vibration analysis.

* apply analytical and numerical sollutions of free and forced global hull-girder vibration.

* apply FEM to ship vibration problems.

* understand problem of the fatigue of ship structural details and calculation procedures for estimation of the fatigue life

## NM4104 (B) : SHIP STRUCTURAL DESIGN AND VIBRATION

Periods/Week : 5. Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 4

Introduction, Historical Review: The Structure Of Wooden Ships. Transition From Wood To Steel. The Structure Of Riveted Ships And Welded Ships. Riveting And Welding In Ship Building. Structural Changes From Riveted To Welded Ships. General Mid-Ship Section Structural Arrangements For Different Types Of Ships- General Cargo Ship, Oil Tanker-Single And Double Hull, Bulk Carrier, Container Ship, Tug, Trawler, Passenger Ship, Cross Channel Ferry.

Structural Parts And Functions And Classification Rules: Different Structural Elements- Keel, Transverse Frames, Longitudinal Frames, Web Frames, Vertical Keelson, Beams, Girders, Floors, Brackets, Pillars, Stem Bars, Stern Frames, Bulkhead Stiffeners, Platings Etc.-Their Structural Configuration, Design Features And Functional Aspects. Assembly Of Various Structural Elements Into The Structural Parts Of The Ship Such As Double Bottom Structure, Side Shell, Single Bottom Structure, Bulk Head Structure, Deck Structure, Aft-End Structure, Fore-End Structure, Super Structure Etc. Structural Design As Per Classification Society Rules. Use Of Relevant Standards In Structural Design.

Structural Design Of Bottom, Side Shell, Bulkhead, Deck, Fore-End, Aft-End Structures : Bottom Structures, Structural Design Of Single Bottom And Double Bottom Structures, Their Structural Configuration And Determination Of Dimensions And Scantlings Of Stiffeners, Frames, Longitudinal, Inner And Outer Bottom Plating, Shell Plating And Framing-Layout Of Strakes, Spacing Of Framing, Shell Expansion Plan, Longitudinal And Transverse Frames, Ordinary And Web Frames, End Connections Of Frames, Bulk Heads-Structural Arrangement Of Bulk Heads, Longitudinal And Transverse Bulk Heads, Determination Of Scantlings And Sizes Of Structural Parts Of Bulkheads, Plating And Stiffening Of Bulk Heads, In Flat, Corrugated, Swaged And Non-Water Tight Bulk Heads, Connection Of Bulkheads With Side Shell, Decks Etc., Partial Bulk Heads.

Decks - Deck Plating, Subdivision Of Strakes And Structural Arrangements Of Longitudinal And Transverse Stiffeners. Determination Of Scantling, End-Connections Of Deck Stiffeners. Fore-End Structure-Stem Profiles, Plating And Stiffening Of The Fore End Structures, Panting Arrangement, Stem Design-Built Up Or Cast, Bulbous Bow Construction, Details Of Arrangements, Chain Locker, Hawse Pipes, Paint Stores, Forward Collision Bulkheads, Determination Of Scantlings.

Aft-End Structure-Stern Profiles, Plating And Stiffening Of Aft-End Structure, Stern Frame - Built Up Or Cast, Details Of Stern Tube, Bossings, Shaft Struts Etc. Different Types Of Rudder Configurations And Stern Fittings For These Rudder Types. Nozzles And Propeller Arrangements. Determination Of Structural Scantlings.

Structural Design Of Engine Room, Superstructure, Cargo Handling Arrangements, Hatches, Special Ships, Welded Structures And Computer Applications: Engine Room – Horizontal Subdivision Of Engine Room, Platforms, Decks, Shaft Tunnel And Recesses, Engine Casting, Foundations Of Diesel Engines, Turbines, Boilers, Auxiliary Machinery. Static And Dynamic Loads In Engine Room. Structural Design Of Engine Room And Determination Of Scantlings.

Superstructure – Structural Design And Details Of Openings, Expansion Joints Etc. Determination Of Scantlings, Construction And Design Of Cargo Handling Systems And Equipment – Loads On Derricks, Masts And Rigging. Determination Of Scantlings. Deck Cranes –Details Of Installation And Structural Arrangements Necessary.

Hatch Covers – Loads Acting On Hatch Covers, Various Types Of Hatch Covers And Their Structural Design.Structural Design Of Special Types Of Ships – Fishing Vessels, Tugs, Tankers, Dredgers, Icebreakers, And Submarines. Stress Concentration And Fatigue In Ship Structures. Computer Applications In Structural Design. Various Methods Of Joining Structural Parts And Elements. Design Of Welded Structures. Problem Of Fracture In Welded Structures. Design And Strength Of Butt – Welds, Fillet Welds, Tee And Corner Joints, Bracketed Connections. Structural Fire Protection.

Hull Vibration Of Ships: Flexural Vibrations Of A Beam. Free And Forced Vibrations, Vibration Of Undammed Spring-Mass System, Damped Vibrations. The Exciting Forces On Hull Of Ships, Modes Of Hull Vibration. Calculation Of Hull Frequencies – Factors Influencing Frequency, Empirical Formulae For Hull Frequency Estimation. Analytical Methods For Calculation Of Hull Modes ( Elementary Treatment Only ). The Stodala's Interpolation Method.

Propeller Exciting Forces. Damping – Types Of Damping. Special Local Vibration Problems – Rudder Vibration, Cavitation, Stress And Vibration Levels, Human Reaction To Vibration.

General Methods Of Reducing Vibrations. Devices For Reducing Main Hull Vibration. Synchronising Devices For Twin – Screw Ships, Rotating Weight Neutralisers, Kurt Nozzles.

*Reference Books:*


1. Strength Of Ship Structures By W. Muckle
2. Ship Construction By D.J. Eyers
3. Principles Of Naval Architecture By Ed.V. Lewis
4. Ship Design And Construction By R.Taggart


## NM 4105(A) CASD
## COMPUTER AIDED SHIP DESIGN

Course Objective: To acquaint and equip with the computer aided design and manufacturing of farm machinery with the help of CAD.

Course outcomes: Successful achievement of master level outcomes is required to receive a passing grade in the course. .

* Ability to create fully constrained solid models that can be quickly modified using standard software tools.

* Ability to use, identify and explain standard features in solid modeling including protrusions, revolutions, cutouts, and patterns

* Ability to use standard software tools to create engineering drawings, or other documents, to fully describe the geometries and dimensions of parts, as well as to document assemblies according to standard practice

* Ability to use standard software tools to create part assemblies and check for clearances.

* Ability to create the drawings of farm implements and their analysis.

* Ability to write the CNC part programming

## NM 4105(A) : COMPUTER AIDED SHIP DESIGN

Periods/week : 5 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 4

Fundamentals of CAD - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- windowing - clipping - 2D and 3D transformations - Linear transformation- Display files for 3D data - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

Introduction to Finite Element Analysis - CAD techniques to finite element data preparation- Automatic mesh generation- presentation of results - 3-dimensional shape description and mesh generation- CAD applications of FEM.

Database systems, structures, entity-relation models, Application to ship design, model manufacturing and testing, CAD applications in ship building, Computer aided manufacture, Numerical control, Part programming.

*Text Books:*


1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover & E.W.Zimmer.
2. Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.


*References:*


1. Computer Aided Design in Mechanical Engineering, by V.Rama Murthy.
2. Elements of Computer Aided Design & Manufacturing, by Y.C.Pao.
3. Computer Aided Kinetics for Machine Design, by D.L.Ryan.
4. Computer Aided Design and Manufacturing, by C.B.Besant & C.W.K.Lui.
5. Computer-Aided Analysis & Design by S. Ghosal, Prentice Hall of India.
6. CAD/CAM/CIM by Radhakrishna, New age international.

## NM 4105(B) : UNDERWATER ACOUSTICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination theory: 3hrs. Credits: 3

Introduction Sound : Wave motion, Sound pressure, Reference intensity, Source level, Radiated power, Limitations to sonar power, Cavitation, Interaction, Changes to arrays, Projector sensitivity, Hydrophone sensitivity, Spectrum level, Sound in air and in sea water,

Arrays : Need for projector arrays, Need for hydrophone arrays, Beam patterns, Directivity of a dipole, The general line array, Shading, Shaded arrays: transmit source levels, Directivity index, Line array: beam pattern vs. steer angle, Broadside array: length and spacing, Beam pattern for a continuous line, DI of a simple dipole, DI of a line array, DI of a planar array, DI of a cylindrical array, DI formulae based for simple arrays, Conformal arrays, Spherical arrays, Volumetric arrays, Beam formers, Domes and arrays.

Propagation of Sound in the Sea : Propagation loss, Losses, Spreading losses, Absorption losses, Spherical spreading and absorption, Propagation in the real ocean, The speed of sound, Sound speed profiles, Deep sound channel, Reliable acoustic path, Surface duct propagation, Convergence zone propagation, Bottom bounce propagation, Propagation loss models, Ray theory and the Hodgson model, Hodgson example, Performance prediction, Multipath propagation

Target Strength : Definition, Formulae, Measurement, Dependence on pulse type and duration, TS of a sphere, TS of some simple shapes, TS of small targets, Mine target strength, Torpedo target strength, Submarine echoes, Beam aspect target strength, Bow aspect target strength, Submarine target strengths, Towed arrays, Target strength reduction, Practical values.

Noise in Sonar Systems : Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel, the sonar environment, Self-noise Electrical noise, Machinery noise, Flow noise, Propeller noise, Variation with speed, Variation with frequency, Directivity, Self-noise and radiated noise, Addition of noise levels, Receiver noise factor, Noise factor of a sonar, Acceptable receiver noise level, Alternative calculation, Practical values

Reverberation : Sources of reverberation, Scattering and reflection, Boundary roughness, Classes of reverberation, Backscattering strength, Reverberation target strength, Volume reverberation, Boundary reverberation, Scattering layers, Volume scattering strength, Sea surface scattering strength, Bottom scattering strength, Variation with fi-equency, Reverberation under ice.

The Sonar Equations : The basic sonar equation, The basic passive equation, The basic active equation, Detection threshold and detection index, Receiver operating characteristics, ROC curves,

Passive Sonar : Radiated noise, Radiated noise: source level, Nature of radiated noise, Practical values, Broadband and narrowband, Normalization, A Note on Swaths, Passive arrays, Passive aural, Passive displays, Formulae for detection threshold, Broadband square law detector, Broadband cross-correlator detector, Narrowband processor, Narrowband amplitude detector processor, Passive ranging, Triangulation, Vertical direct passive ranging, Horizontal direct passive ranging, Towed arrays, Bearing ambiguity, Self-noise,

Active sonar : Pulse types, Active sonar equations, Reverberation index, Reverberation and Target Echoes in the main lobe, and sidelobes, Range, pings and doppler shift, Reverberation rejection by CW pulses, Practical reverberation envelopes, Fulland half-beam processing, Beam forming, FM phase binning process, CW processing, Large aperture array, Detection performance, Noise and reverberation-limited detection ranges:, Ambiguity diagrams, Very long pulses, Operational degradation factor, Active displays, Unified detection and classification, Bandwidth, Beamwidth, CADAC, Levels of CADAC, CADAC and pulse features, Statistical analysis, Amplitude profiles, Multipath affects classification

*Textbook:*

Sonar for Practicing Engineers – A.D. Waite - Third Edition – John Wiley

References:

1. Principles of Underwater Sound – (1983) Robert J Urick – Mc Graw Hill Publications

2. Understanding Active Noise Control C.H. Hansen

3. Underwater Acoustic Systems Rodney F.W. Coates

4. Underwater acoustics Leon Camp

## NM4106 (HSS) : INDUSTRIAL ENGINEERING AND MANAGEMENT

***Course Objectives:***

1. To familiarize the students with the concepts of Management.
2. To relate the concepts of Management with industrial organizations.
3. To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.
4. To set forth a basic framework for understanding Entrepreneurship.

***Course Outcomes:***

On completion of the course, the students will be able to:

1. Understand the roles, skills and functions of management.
2. Distinguish the different types of business organizations.
3. Identify the factors involved in Production Operations Management.
4. Diagnose organizational problems and take suitable decisions.

5. Establish good Human Resource Management practices.

6. Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities.

Basic Concepts of Management :

Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

*Text Books:*

(1 ) Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

(2) Vasant Desai , The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth),HImalayan Publishing House, 2018.

*Reference Books:*

(1) Aryasri , A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

(2) Sheela, P. , and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

## NM 4107 (SC) Advanced NAPA Practice

Lab Periods/week : 3 Sessional. : 50

Exam: 50 Credits: 1.5

***Course Objectives***

* The objectives of the course are to provide training and provide hands on experience to the students on NAPA software for the purpose of hydrostatic calculations and resistance calculations

***Course Outcomes***

* At the end of the course, the student will be in a position to model a ship using the softare

* perform a detailed hydrostatic calculation

* Obtain the ship resistance

NAPA Main window features, Project Settings, Hull Modelling, Hydrostatic Calculations, Design Hydrostatics, Hydrostatics, Resistance, Report writing and explanation

## B. Tech -IV Year- II Semester

| | | | | | | |
|---|---|---|---|---|---|---|
| NM 4201 | PROJ | Project work | 100 | 100 | 200 | 14 |
| Total credits | | | | | | 14 |

## PROFESSIONAL ELECTIVES:

## I. INTRODUCTION TO OFFSHORE STRUCTURES

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objectives:***

This subject introduces students to basic naval architectural knowledge e.g. naval architectural terms, ship components and simple hydrostatics calculations. It also enables students to familiarize themselves with various offshore engineering sectors including basic knowledge on types of offshore structures and their functions

***Course outcomes:***

On successful completion of this unit, students should be able to:

* Appreciate the shipbuilding industry

* Acquire the naval architectural principles and concepts

* Use the methods of numerical integration and quadrature

* Describe in detail a number of different offshore facility concepts, including the advantages and

* Disadvantages of each understand the various types of fixed and floating offshore platforms, including key design, fabrication

* And installation issues, as well as areas of applicability describe in detail a number of ships from recreational to naval, small to big, operating on or under the

* Sea acquire the basic knowledge of mooring systems and subsea technology

Fundamentals of physical oceanography, drilling technology, mooring systems, study of Environmental forces i.e. waves, wind, tides and current. Types of drilling rig suitability for particular applications. Drill ship- special equipment and operation of drilling rigs- supply crafts, structural arrangements, and semi-submersibles. Various types of offshore structures- jacket platforms, gravity platforms, complaint structures- guyed tower, tension leg platform etc. Structural systems used. Load calculation- wave, wind, current and functional loads, Soil structure interaction. Analysis of offshore structural components matrix methods-plane frame, grid and space frames. Introduction to dynamic analysis, transportation, launching and upending problems, preliminary design aspects of offshore structures. Safety and reliability of offshore structures.

*Reference books:*

1. Hydrodynamics of Offshore Structures by S.K.Chakravarthy

2. Offshore Structural Engineering by Thomas H.Dawson

3. Mechanics of Wave Forces on Offshore Structures by Turgut Sarpkaya & M. Isaacson.

## II. OCEAN STRUCTURES AND MATERIALS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objectives:***

This subject introduces students to ocean structure knowledge e.g. naval architectural terms, ship components and simple hydrostatics calculations. It also enables students to familiarize themselves with various offshore engineering sectors including basic knowledge on types of offshore structures and materials

***Course outcomes:***

On successful completion of this unit, students should be able to:

* Appreciate the knowledge on Oil and gas resources

* Acquire the Metal principles and concepts

* Use the methods of design and construction

* Describe in detail a number of different Materials facility concepts,

Brief introduction of ocean, Oil and gas resources. Near shore structures. Different types of ocean structures and systems (fixed, floating, semi-submersibles, submersibles, TLP s pipelines, intakes) for exploitation of oil and gas, minerals and energy.

Different materials for marine applications: Behavior of Metals, concrete and other Composite materials for marine environment. Principles of corrosion, properties and selection of materials, Non-destructive testing of materials and structures. Ocean pollution and its effect on ocean structures. Dredging and dredgers.

Brief outline of planning, design and construction. Regulation and codes of practices The environment and environmental forces. Structural analysis and principles of design Foundation and sea bed anchors. Towing, launching and installation.

*References :*

1. Ben C.Gerwick, Jr., Construction of Marine and Offshore Structures, CRC Press, New York, 2000

2. Reddy, D.V.and Arockiasamy, M., Editors, Offshore Structures, Vol.I and II, Krieger Publishing Company, Florida, 1991

3. Per Bruun, Port Engineering, Volume I and II, Gulf Publishing Company, 1989

## III. FINITE ELEMENT ANALYSIS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objective:***

* To introduce the concepts of Mathematical Modeling of Engineering Problems.

* To appreciate the use of FEM to a range of Engineering Problems

***Course Outcomes:***

At the end of the course, a student will be able to

* CO1: apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence.

* CO2: analyze linear 1D problems like bars and trusses; 2D structural problems using CST element and analyse the axi-symmetric problems with triangular elements.

* CO3: write shape functions for 4 and 8 node quadrilateral, 6 node triangle elements and apply numerical integration to solve; 1D and 2D; stiffness integrations.

* CO4: solve linear 2D structural beams and frames problems; 1Dheat conduction and convection heat transfer problems.

* CO5: evaluate the Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity

Fundamental Concepts: Introduction, Historical background, Outline of presentation, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-Ritz method, Hamilton's principle. Galerkin's method, Saint Venant's principle.

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, in plane and Bending, problem modeling and boundary conditions.

Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical integration, Higher-order elements. Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

*Text Book:*

1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only).

*References:*

1. Introduction to Finite Element Method, by Abel & Desai.
2. Finite Element Method, by O.C. Zienkiewicz.
3. Concepts and Applications of Finite Element Analysis, by Robert D. Cook.
4. Introduction to Finite Element Method, by J.N.Reddy.

## IV. MARINE MANUFACTURING TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course outcome:***

Introduce students to theory and operation of manufacturing including manufacturing processes and equipment overview, manufacturing design, production process and flow, materials, machine operations and logistics.

***Course objective:***

* Identify the different stages of a manufacturing process.
* Interpret the elements of the product design process.
* Identify the common machines used in a manufacturing process.
* Explain the operations and capabilities of machines used in manufacturing.
* Determine the operations used in finishing manufactured products.
* Explain the operations and capabilities of automated machines used in manufacturing.
* Interpret the functionality of base lining and documentation in a manufacturing process.
* Determine the main elements of quality assurance in a process.
* Identify characteristics of end product logistics.

### SYLLABUS

Foundry: Foundry tools and appliances, layout – pattern types, materials, allowances, pattern making, moulding sands, types. Moulding methods, equipment for moulding, casting methods.

Lathe: Working principle, classification, specification, different operations on a lathe, methods of taper turning, cutting speed, feed, depth of cut, machining time and power required for cutting. Turret and capstan lathes.

Shaper and Planer (Elementary Treatment only): Principal parts, classification – quick return mechanisms, table feed mechanism working on shaper and planer, a comparison. Work holding devices.

Drilling and Boring Machines (Elementary Treatment only): Classification, specifications, cutting speed, feed, machining times, parts and description of boring machines, types.

Power Press: Operation, components, classification, selection, cutting dies, power requirements, power press operations, punching, blanking, deep drawing.

Linear and angular measurements: Micrometers, Slip gauges, Vernier and optical bevel Protractors, sine bar Angle gauges.

Comparators: Types, Mechanical, Electrical, Electronic comparators. Measurement of Straightness- flatness- square ness and symmetry-parallelism and circularity.

Metrology: Metrology of screw threads and Metrology of gears (Measurement of Pitch and tooth thickness only).

Grinding: Introduction-abrasives-grinding wheels, bonding processes, selection of grinding wheels-grinding machines-classification-honing-lapping, super-finishing, buffing, polishing, selection of process parameters.

*Text Books:*

1. Engineering Metrology by R.K. Jain
2. Production Technology by R.K. Jain and S.C. Gupta

*References:*

1. Production Technology by P.C. Sharma
2. Workshop Technology, Vol.1, 2&3 by W.A.J. Chapman
3. Machine Tools by Bhattacharya

## V. FISHING VESSELS TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Importance of fishing, Classification of fish for harvesting. Fishing methods- Purse seining, Drift netting, Gillnet fishing, Long line fishing. Pole and line fishing, Trawling, Harpooning.

Fishing Gear- Towed gear, Bottom trawling, side trawling, Towing arrangements, stern trawling operations and equipment, multiring trawling, Midwater trawling, Purse seining Types, Analysis of fishing nets.

Storing and preservation of fish on board a vessel, Fish hold arrangement. Insulation, icing and freezing. Refrigeration machinery.

Design of fishing vessels. Side trawlers, stern trawlers, purse seining. General arrangement, Layout and equipment on deck. Determination of main dimensions. Estimation of component weights. Development of lines. Estimation of resistance. Design of propellers for trawlers. Machinery- main and auxiliary, Electrical systems, structural arrangements. Materials for the construction of fishing vessels.

Economics of fishing vessels. Estimation of initial and operation costs. The influences of size, speed, power, selling price, distance optimised fishing vessel design. Design and economics of simple low cost country fishing crafts.

*References Books:*

1. Design of Small Fishing Vessels by John Fyson
2. Fishing Boats of the World by Jan-Olof Traung

## VI. MARINE HYDRODYNAMICS

Course Objectives: To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

Course Outcomes: Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

Small Amplitude Wave Theory Formulation and Solution: Review of hydrodynamics-Boundary Value Problems, summary of two-dimensional periodic water wave BVP, solution of linearized water wave BVP for a horizontal bottom, dispersion equation, engineering wave properties-water particle, kinematics of progressive waves, pressure field under a standard wave, partial standing waves, energy and energy propagation in progressive waves- principle of conservation of energy. Energy Flux.

Wave Forecasting: Generation of waves-theories of wave generation by Kelvin, Phillips, Milne, Jeffrey, Swerdrup and munk. Concept of fully developed sea, Characteristics of ocean waves, significant wave height and period, wave height variability, energy spectra of waves, simplified wave prediction models-SMB and PNJ. Methods, wave forecasting charts, effects of moving storms and variable wind speed and direction.

Wave Transformation and Wave statistics: Transformation of wave entering shallow water, shoaling of waves in shallow water, wave reflection, refraction and diffraction, combined refraction, diffraction, and wave breaking. Wave Height distribution-single wave train, wave groups, narrow banded spectra, Rayleigh's distribution, wave spectrum, directional wave spectrum-JONSWAP, PNJ and Bretschneider spectra.

Wave Forces: Wave forces on vertical cylindrical bodies due to non-breaking waves – Basic concepts, calculations of forces and moments, Transverse forces due to eddy shedding (Lift forces), selection of hydrodynamic force coefficient, $C_d$ and $C_m$, calculation of forces and moments on groups of vertical and non-vertical cylindrical bodies due to breaking and non-breaking waves.

*Text Book:*

1. Shore Protection Manual, Vols. 1 & 2 by US army coastal engineering research center publication

*Reference Books:*

1. Water Wave Mechanics by Dean and Dlrymple
2. An introduction to Hydrodynamics and Water Waves by B. Le Mehaute
3. Estuary and Coastline Hydrodynamics by A.T. Ippen

## VII. ADVANCED WELDING TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Introduction: Classification of welding and related processes. General conditions for welding, edge preparations, and design of welded joints, welding codes and symbols, weldability of metals and metallurgy in welding.

Plastic Welding: Forge Welding: Types, Forged joints etc. Resistance Welding: Principle, types, spot, seam, etc. Thermit welding.

Gas Welding: Principle, equipment, different gas flames, gas welding techniques, types of gas welding, oxy-acetylene, air-acetylene, and oxy-hydrogen welding etc.

Arc Welding: Principle and theory. Arc welding equipment, arc welding current and voltage, polarity of electrodes, angularity of electrodes, precautions in arc welding. Arc welding types, Carbon arc, metal arc, MIG, TIG etc.

Solid State Welding: Principle and types. Latest welding techniques, electron beam, laser beam, metal flame spraying etc. Under water welding (elementary treatment only). Related processes, oxy-acetylene cutting, arc cutting, brazing, soldering etc.

Welding of various Metals: Cast Iron, steel, non-ferrous metals, etc. Welding defects, inspection and testing-design for welding. Safety practices and training in welding and welding machines (elementary treatment).

*Text Books:*

1. Welding Engineering by R.L. Agrawal and Tahil Manghnani
2. A Text book of Welding Technology by O.P. Khanna
3. Welding Technology by N.K. Srinivasan

*References:*

1. Welding Engineering and Technology by R.S. Parmar
2. Welding and Welding Technology by Richard L. Little
3. Welding by A.C. Davies
4. Production Technology by R.K. Jain and S.C. Gupta
5. Elements of Workshop Technology, Vol.1 by S.K. Hajra Choudury
6. Welder Trade Theory by S.K. Singh

## VIII. SEA KEEPING AND MANEUVERABILITY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory : 3hrs. Credits: 3

***Course outcomes:***

* Apply the concepts of Static Equilibrium and Archimedes' Principle to the operation of a ship.

* Demonstrate the ability to assess the stability condition of a ship. Predict the effect of planned shipboard evolutions on ship stability.

* Understand the significance of damage to a ship which has compromised its watertight integrity. Use hydrostatics to make intelligent and safe choices to maintain a ship afloat and upright.

* Understand the structural arrangement of a ship, including the choice of materials and the stresses developed by loads encountered in its operating environment.

* Understand the different components that make up a ship's resistance and the manner in which the propulsion plant transmits its power to overcome those forces.

* Understand factors affecting the seakeeping and maneuverability of ships in a seaway.

***Course objective:***

This course is an introduction to the applied science of ship systems. The course describes ships and submarines and how they remain afloat from a design and application perspective. Included are topics in hydrostatics, ship stability and operability, materials, fluid dynamics and propulsion.

Introduction to sea keeping: Importance of sea keeping analysis. Behaviour of a ship in a seaway. Regular waves, Sinusoidal and trochoidal Theories. Chacteristics of waves; Sea surface. Analytical and statistical representations. Descriptive characterisation of the sea. Average and significant wave heights. Wave histogram. Characterisation by energy spectrum. Standard sea spectra. Beaufort scale.

Ship motions in regular waves: Surge, sway, heave, roll, pitch and yaw. Coupled and uncoupled motions. Equations of motion, inertial, damping, restoring and exciting forces and moments. Determination of the forces and moments. Tuning factor and Magnification factor. Added mass. Coupled heaving and pitching. Motions in shallow water.

Ship Motions in Irregular waves: Encounter spectrum. Response amplitude operators and their calculation by theory and experiment. Motion spectrum and statistical characteristics of motions in irregular waves.

Dynamic effects: Relative bow motion. Deck wetness and slamming. Added Resistance in waves. Added power. Power increase due to wind and waves. Loss of speed in a seaway. Loads due to motion. Wave loading and bending moments. Vertical and Rolling effects. Sea sickness

Stabilization of ship motions: Roll stabilizers- Bilge keels, Gyroscopic stabilizers, Movement of weight, Rudder action, Jet flaps, Stabilizing fins, Passive and Active tank stabilisers.

Pitch stabilization methods: Ship motion experiments. Generation of Regular and Irregular waves. Captive and free running model tests. Full scale Tests.Design considerations for sea keeping. Seakeeping criteria. ITTC Guidelines. Effect of design parameters and hull form on seakeeping.

Introduction to Manoeuvrability: Controlled and uncontrolled motions. Control Loop. Course keeping. Motion stability of ocean vehicles. Equations of motion. Hydrodynamic derivations. Stability criterion. Course changing. Tuning circle, zigzag and spiral manoeuvers. Heel while turning. Manoeuvering trials.

Control Surfaces: Control surface geometry. Rudders- types and characteristics. Effect of stall, aeration and cavitation.(Flow around

rudder,Influence of ship- features on controls fired stability.) Design of rudders. Calculation of steering gear torque. Bending moment and stresses in rudder stock. Structural design of rudders. Other maneuvering devices. Maneuvering in restricted waters. Squat in shallow water. Bank suction effects- Interaction between ships. Theoretical determination of hydrodynamic derivatives of ship and control surfaces. Experimental determination of hydrodynamic derivatives. Estimation of maneuvering characteristics form hydrodynamic derivatives.

*References:*

1.Dynamics of Marine Vehicles by Rameshwar Bhattacharya.

2.Principles of Naval Architecture, Vol. III by Ed.V. Lewis

## IX DYNAMICS OF OFFSHORE STRUCTURE

Periods/week : 4 Ses. : 30 Exam : 70

Examination theory: 3hrs. Credits: 3

Dynamic perspective. Introduction to different types of ocean structures. Development of structural forms for deep and ultra deep waters. Basis of structural design of ocean structures. Environmental forces. Structural dynamics. Basics-SDOF systems Fundamentals of structural dynamics. Mathematical modelling of structural systems. Single Degree of Freedom (SDOF) systems. Characteristics of sing degree of freedom model – formulation of equation of motion. Free and Forced vibration of single degree of freedom systems. Undamped and damped systems.

Structures in the offshore environment - Description of typical offshore structures – Fixed- Compliant Floating - Solid fluid interaction parameters - Spring factor - Added mass and damping Response of offshore structures - Modelling of offshore structures – single and multi-degree freedom systems – effect of foundations

Structural action of ocean structures - Multi-Degree of freedom (MDOF) systems. Formulation of equation of motion - Influence coefficients - Eigen value problems. Dynamic matrix method. Dunkerley's method - Matrix iteration method - Stodla's method.Mode superposition. Mode truncation.Rayleigh-Ritz method.Damping.Rayleigh damping – Caughey damping. Application of dynamics. Fluid structure interaction (FSI).Perforated members. Articulated tower (AT).Freely moving structures - Stability of submerged and floating structures - Stability at small and large angles

Experimental Structural Dynamics. Experimental studies-free floating studies-free decay studies. Experimental investigation on perforated cylinders & perforated TLP model. Structural dynamics, introduction to stochastic dynamics of ocean structures. Motion analysis in random waves - Low frequency oscillation. Dynamic positioning.

Stochastic Dynamics – Introduction to Stochastic Dynamics of ocean structures. Fatigue Prediction. Random Environmental Processes – Response Spectrum.

*References*

1. Wilson, J. F., Dynamics of Offshore Structures, John Wiley, 2002.

2. Clauss, G, Lehmann, E &Ostergaard, C., Offshore structures - Vols 1 & 2, SpringerVerlag, 1992. 3. Chakraborti, S. K., Non Linear methods in Offshore Engineering, Elsevier SciencePubl, .2002. 4. Hooft, J. P., Advanced Dynamics of Marine Vehicles, John Wiley, 1982.

## X. DESIGN OF SMALL CRAFTS

Periods/week : 5 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 4

***Course objectives:***

provides a broad overview of craft design, construction and operation. The craft design process may be broken down broadly into two stages: Conceptual and/or preliminary design. The preliminary design process will normally take the form of a techno-economic appraisal, using a fundamental engineering economy approach.

***Course outcome:***

* demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work

Tugs and towing vessels: Types, stability requirements, Bollard pull, powering, Features of tow hook, Equipment. General arrangement, Special features of pusher tugs, Kort-nozzle, Voith-Schneider and Schottel propulsion in tugs. Design aspects.

Dredgers: Types of dredgers, Hydrostatics and stability considerations. Powering and dredging machinery and equipment. Disposal of dredged material. Design considerations.

High speed crafts: Their role in offshore and naval operations. Special features. Design considerations

Fishing vessels: Types of fishing vessels and fishing methods. Special features. Stability requirements and IMCO recommendations. General arrangement. Fishing gear and equipment. Preservation and processing of catch and by-products. Fishing vessel design.

*Text Books:*

1.Principles of Naval Architecture by Ed.V. Lewis

## XI NAVAL VESSELS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Historical development of different types of naval vessels: Distinguishing features of warship types. Indigenous design and production of naval vessels. Mission requirements and constraints. Concept exploration and development of warship criteria. Determination of main dimensions. Volumes based and weight based criteria. Space allocation and general arrangement.

Design of Hull Form: Warship resistance data, Hydrodynamics of naval vessels. Propellers for warships. Design and construction. Propeller data for heavily loaded propellers. Hydrodynamic design methods. Stability criteria for warships. Damage survival considerations.

Main and auxiliary machinery in warships: Comparative methods of steam, diesel and gas turbine plants. Combined plants. Requirements of sea keeping and stability platform. Stabilisation systems. Special manoeuvring requirements for naval vessels.

Structural arrangements in naval ships: Structural design criteria and design procedures. Shock and methods to reduce its effects. Accommodation. Habitability standards. A/C requirements. Nuclear, bacteriological and chemical defense arrangements. Weapon systems. Guns torpedoes, depth chargers, mines and missiles. Radar and Sonar weapon control systems. Counter Measures.

Detailed study of some modern naval ships: Submarine: General description, pressure hull external structure, diving and surfacing systems. A/C and ventilation systems. Stability, equilibrium polygon. Distance when submerged and while on surface. Propulsion system. Rudder and hydroplanes. Nuclear submarines.

## XII.ADVANCED SHIP THEORY

***Course Objectives:***

* The objectives of the course are

* Teach the student about the various hazards during the life of a marine engineer and the protection that should be provided against those Hazards

* Teach the students how to design a Ship Girder

* Teach the student how to design internal members like panel etc

* Teach the student about the internal and external factors of marine engineers life.

***Course Outcomes***

* At the end of the course the student will

* Be in a position to know about Various Hazards and protection and the environmental pollution aspects of ship's life

* Be capable of performing simple standard calculation for the ship girder,

* Be capable of structural Design of Stiffened plating, panels plating frameworks etc

* Know about the internal and external environmental aspects of the Ship Environment

Hazards and Protection - Flooding and collision Safety of Life at Sea (SOLAS), Abnormal Waves, Environmental Pollution

LO-1: To explain Hazards and protection

The Ship Girder - Standard calculation for the ship girder, materials considerations, Structural Design and Analysis - Stiffened plating, panels plating, frameworks, realistic assessment of structural elements, Fittings

LO-2: To provide Design and Analysis of the ship girder The Ship Environment and Human Factors - The external environment - sea, waves, climate, physical limitations, internal environment, motions, vibration and noise

LO-3: To Explain Human Factors and Ship environment

*Textbook*

Basic Ship Theory by Rawson and Tupper – B&H

*References*

Muckle's Naval Architecture, by Eric Tupper – B&H

Principles of Naval Architecture – SNAME Publications

## XIII. UNDER WATER ACOUSTICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Introduction Sound : Wave motion, Sound pressure, Reference intensity, Source level, Radiated power, Limitations to sonar power, Cavitation, Interaction, Changes to arrays, Projector sensitivity, Hydrophone sensitivity, Spectrum level, Sound in air and in sea water,

Arrays : Need for projector arrays, Need for hydrophone arrays, Beam patterns, Directivity of a dipole, The general line array, Shading, Shaded arrays: transmit source levels, Directivity index, Line array: beam pattern vs. steer angle, Broadside array: length and spacing, Beam pattern for a continuous

line, DI of a simple dipole, DI of a line array, DI of a planar array, DI of a cylindrical array, DI formulae based for simple arrays, Conformal arrays, Spherical arrays, Volumetric arrays, Beam formers, Domes and arrays.

Propagation of Sound in the Sea : Propagation loss, Losses, Spreading losses, Absorption losses, Spherical spreading and absorption, Propagation in the real ocean, The speed of sound, Sound speed profiles, Deep sound channel, Reliable acoustic path, Surface duct propagation, Convergence zone propagation, Bottom bounce propagation, Propagation loss models, Ray theory and the Hodgson model, Hodgson example, Performance prediction, Multipath propagation

Target Strength : Definition, Formulae, Measurement, Dependence on pulse type and duration, TS of a sphere, TS of some simple shapes, TS of small targets, Mine target strength, Torpedo target strength, Submarine echoes, Beam aspect target strength, Bow aspect target strength, Submarine target strengths, Towed arrays, Target strength reduction, Practical values.

Noise in Sonar Systems : Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel, the sonar environment, Self-noise Electrical noise, Machinery noise, Flow noise, Propeller noise, Variation with speed, Variation with frequency, Directivity, Self-noise and radiated noise, Addition of noise levels, Receiver noise factor, Noise factor of a sonar, Acceptable receiver noise level, Alternative calculation, Practical values

Reverberation : Sources of reverberation, Scattering and reflection, Boundary roughness, Classes of reverberation, Backscattering strength, Reverberation target strength, Volume reverberation, Boundary reverberation, Scattering layers, Volume scattering strength, Sea surface scattering strength, Bottom scattering strength, Variation with fi-equency, Reverberation under ice.

The Sonar Equations : The basic sonar equation, The basic passive equation, The basic active equation, Detection threshold and detection index, Receiver operating characteristics, ROC curves,

Passive Sonar : Radiated noise, Radiated noise: source level, Nature of radiated noise, Practical values, Broadband and narrowband, Normalization, A Note on Swaths, Passive arrays, Passive aural, Passive displays, Formulae for detection threshold, Broadband square law detector, Broadband cross-correlator detector, Narrowband processor, Narrowband amplitude detector processor, Passive ranging, Triangulation, Vertical direct passive ranging, Horizontal direct passive ranging, Towed arrays, Bearing ambiguity, Self-noise,

Active sonar : Pulse types, Active sonar equations, Reverberation index, Reverberation and Target Echoes in the main lobe, and sidelobes, Range, pings and doppler shift, Reverberation rejection by CW pulses, Practical reverberation envelopes, Fulland half-beam processing, Beam forming, FM phase binning process, CW processing, Large aperture array, Detection performance, Noise and reverberation-limited detection ranges:, Ambiguity diagrams, Very long pulses, Operational degradation factor, Active displays, Unified detection and classification, Bandwidth, Beamwidth, CADAC, Levels of CADAC, CADAC and pulse features, Statistical analysis, Amplitude profiles, Multipath affects classification

*Textbook:*

Sonar for Practicing Engineers – A.D. Waite - Third Edition – John Wiley References:

1. Principles of Underwater Sound – (1983) Robert J Urick – Mc Graw Hill Publications
2. Understanding Active Noise Control C.H. Hansen
3. Underwater Acoustic Systems Rodney F.W. Coates
4. Underwater acoustics Leon Camp

## XIV. MARINE ENGINEERING -II

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Engine room arrangements for different power plants – Functions of Auxiliary equipment – Bilge and ballast systems – Other Auxiliaries.

Piping – Piping fittings and valves – Control valves, materials and corrosion in pipes – Colorcodes – Steam traps, Drains and glands.

Pumping systems. General principles - Simple and duplex pumps – Rotary positive displacement pumps —- Centrifugal pumps – Axial flow pumps - Bilge , ballast & sanitary

pumps – Boiler feed pumps – air pumps and Ejectors. Centrifugal compressors – Working principles – Impeller and diffuser design.- Performance characteristics – Blade profiles.

Airflow compressors –Working principles – Types – Performance characters – Aerofoil theory – Blade design.

Condensers, Evaporators, Deaerators and purifiers - Auxiliary condensers – Evaporating plant – Distillation plant – Feed heaters deaerators oil purifiers – Self-changing purifiers.

Steering gear- Types of Steam steering gear, Telemotor gear, Hand steering gear, Hydraulic systems, Electro hydraulic steering gear – Electrical steering gear.

*Text Books:*

1. The running and maintenance of marine Machinery - J Cowley.
2. Marine Auxiliary machinery - W.J Fox.
3. Marine Auxiliary machinery and systems - M Khetaguroo
4. Theory and design of steam and gas turbines – Lee

## XV. ADVANCED FLUID MECHANICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Course Objectives : This course offers basic knowledge on fluid statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

Course Outcomes: The student will be able to:

* Identify importance of various fluid properties at rest and in transit.

* derive and apply general governing equations for various fluid flows

* Understand the concept of boundary layer theory and flow separation.

* Plot velocity and pressure profiles for any given fluid flow.

* evaluate the performance characteristics of hydraulic turbines and pumps

Fluid Kinematics & Fluid Dynamics: Stream line- Stream tube- Stream function- Potential function- Classification of flows- Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity and circulation- Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy- Bernoulli's equation and its applications- Vortex motion- Free and forced vortices- Basic solutions of ideal fluid flows- Flow net analysis.

One dimensional Viscous Flow: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes- Laminar and turbulent regimes- Flow potential and flow resistance- Flow through branched pipes, Momentum equation- Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction, flow through porous media- Darcy's equation. Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations. Laminar Boundary Layer: Momentum integral equation- Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness.

Turbulent Boundary Layer: Laminar- Turbulent transition- Momentum equations and Reynold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.

Dimensional Analysis and Modeling Similitude: Fundamental and derived dimensions- Dimensionless groups- Buckingham p-theorem- Rayleigh method- Model testing- Types of similarity- Geometric, Kinematic and Dynamic similarities- Hydraulic diameter.

Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

*Text Book:*

Fluid Mechanics, by A.K.Mohanty, Prentice Hall of India Pvt.Ltd.

*References:*

1. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications.

2. Foundations of Fluid Mechanics, by Yuan, Prentice Hall of India.

3. Fluid Mechanics and its Applications, by S.K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

4. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, S.Chand & Co.

5. Fluid Mechanics by Kothandaraman and Rudramoorthy.

## OPEN ELECTIVES:

## I. INDUSTRIAL ELECTRONICS

Periods/week: 4 Ses. : 30 Exam: 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Devices: Semi-conductor diode, Zenor diode - Transistor - Silicon control rectifier. Rectifiers, Amplifiers, Oscillators, Cathode ray oscilloscope.

Industrial Applications: Poly-phase rectifiers - Control circuits - Motor speed control voltage control, Time delay relay circuits - Photo electric circuits.

Resistance welding, inducting heating - Dielectric heating.

Servomechanism: Open loop and closed loop systems (Elementary treatment only).

Introduction to Digital Electronics: Fundamentals of digital electronics, Number system and codes, Logic gates, Boolean algebra, Arithmetic - logic units, Flip-flops, Registers and counters, Memories: ROM, PROM, EPROM and RAM.

Introduction to Microprocessors: The Intel-8085 microprocessor; Architecture, Instruction set, Execution of instructions, Addressing structures,

Timing and machine cycles of 8085 and programming I/O operations, Interrupts, Serial input and serial output, Programming the I/O ports, Programming the timer.

*Text Books:*

1. Industrial Electronics by Mithal (Khanna Publications).

2. Digital Computer Electronics - An Introduction to Micro Computer by Albert Paul Malvino, Tata McGraw-Hill Publishing Co. Ltd., New Delhi-2.

*References:*

1. Engineering Electronics by Ryder-McGraw Hill.

2. Micro Processors by Leventhal.

3. Industrial Electronics by Bhatacharya, Tata Mc-Graw Hill.

4. Industrial Electronics and Control by S.K. Bhatacharya and S. Chatarjee, 1995 Ed., Tata Mc-Graw Hill Pub. Co. Ltd.

## II. NAPA /RHINO /EXACT FLAT LAB

measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement. Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

*Text Books:*

1. Automatic Control Systems, by Benjamin C. Kuo.

2. Mechanical Measurements, by R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

*References:*

1. Experimental Methods for Engineers, by J.P.Holman, McGraw-Hill.

## IV SHIP VIBRATION

Periods/Week : 5. Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 4

***Course objective:***

Presentation of the basic notions of the vibration theory and ship vibration. Definition of vibration problems and consideration of possibilities for their solutions. Reliable prediction of vibration level in the ship design stage. Review of vibration measurement procedures and vibration remedy

***Course outcomes:***

Upon completion of the course, students will be able to:

* understand basic principles of ship vibration.

* prepare input data for global hull-girder ship vibration analysis.

* apply analytical and numerical sollutions of free and forced global hull-girder vibration.

* apply FEM to ship vibration problems.

* understand problem of the fatigue of ship structural details and calculation procedures for estimation of the fatigue life

Introduction, Historical Review: The Structure Of Wooden Ships. Transition From Wood To Steel. The Structure Of Riveted Ships And Welded Ships. Riveting And Welding In Ship Building. Structural Changes From Riveted To Welded Ships. General Mid-Ship Section Structural Arrangements For Different Types Of Ships- General Cargo Ship, Oil Tanker-Single And Double Hull, Bulk Carrier, Container Ship, Tug, Trawler, Passenger Ship, Cross Channel Ferry.

Structural Parts And Functions And Classification Rules: Different Structural Elements- Keel, Transverse Frames, Longitudinal Frames, Web Frames, Vertical Keelson, Beams, Girders, Floors, Brackets, Pillars, Stem Bars, Stern Frames, Bulkhead Stiffeners, Platings Etc.-Their Structural Configuration, Design Features And Functional Aspects. Assembly Of Various Structural Elements Into The Structural Parts Of The Ship Such As Double Bottom Structure, Side Shell, Single Bottom Structure, Bulk Head Structure, Deck Structure, Aft-End Structure, Fore-End Structure, Super Structure Etc. Structural Design As Per Classification Society Rules. Use Of Relevant Standards In Structural Design.

Structural Design Of Bottom, Side Shell, Bulkhead, Deck, Fore-End, Aft-End Structures: Bottom Structures, Structural Design Of Single Bottom And Double Bottom Structures, Their Structural Configuration And Determination Of Dimensions And Scantlings Of Stiffeners, Frames, Longitudinal, Inner And Outer Bottom Plating, Shell Plating And Framing-Layout Of Strakes, Spacing Of Framing, Shell Expansion Plan, Longitudinal And Transverse Frames, Ordinary And Web Frames, End Connections Of Frames, Bulk Heads-Structural Arrangement Of Bulk Heads, Longitudinal And Transverse Bulk Heads, Determination Of Scantlings And Sizes Of Structural Parts Of Bulkheads, Plating And Stiffening Of Bulk Heads, In Flat, Corrugated, Swaged And Non-Water Tight Bulk Heads, Connection Of Bulkheads With Side Shell, Decks Etc., Partial Bulk Heads.

Decks - Deck Plating, Subdivision Of Strakes And Structural Arrangements Of Longitudinal And Transverse Stiffeners. Determination Of Scantling, End-Connections Of Deck Stiffeners. Fore-End Structure-Stem Profiles, Plating And Stiffening Of The Fore End Structures, Panting Arrangement, Stem Design-Built Up Or Cast, Bulbous Bow Construction, Details Of Arrangements, Chain Locker, Hawse Pipes, Paint Stores, Forward Collision Bulkheads, Determination Of Scantlings.

Aft-End Structure-Stern Profiles, Plating And Stiffening Of Aft-End Structure, Stern Frame - Built Up Or Cast, Details Of Stern Tube, Bossings, Shaft Struts Etc. Different Types Of Rudder Configurations And Stern Fittings For These Rudder Types. Nozzles And Propeller Arrangements. Determination Of Structural Scantlings.

Structural Design Of Engine Room, Superstructure, Cargo Handling Arrangements, Hatches, Special Ships, Welded Structures And Computer Applications: Engine Room – Horizontal Subdivision Of Engine Room, Platforms, Decks, Shaft Tunnel And Recesses, Engine Casting, Foundations Of Diesel Engines, Turbines, Boilers, Auxiliary Machinery. Static And Dynamic Loads In Engine Room. Structural Design Of Engine Room And Determination Of Scantlings.

Superstructure – Structural Design And Details Of Openings, Expansion Joints Etc. Determination Of Scantlings, Construction And Design Of Cargo Handling Systems And Equipment – Loads On Derricks, Masts And Rigging. Determination Of Scantlings. Deck Cranes –Details Of Installation And Structural Arrangements Necessary.

Hatch Covers – Loads Acting On Hatch Covers, Various Types Of Hatch Covers And Their Structural Design.Structural Design Of Special Types Of Ships – Fishing Vessels, Tugs, Tankers, Dredgers, Icebreakers, And Submarines.

Stress Concentration And Fatigue In Ship Structures. Computer Applications In Structural Design. Various Methods Of Joining Structural Parts And Elements. Design Of Welded Structures. Problem Of Fracture In Welded Structures. Design And Strength Of Butt – Welds, Fillet Welds, Tee And Corner Joints, Bracketed Connections. Structural Fire Protection.

Hull Vibration Of Ships: Flexural Vibrations Of A Beam. Free And Forced Vibrations, Vibration Of Undammed Spring-Mass System, Damped Vibrations. The Exciting Forces On Hull Of Ships, Modes Of Hull Vibration. Calculation Of Hull Frequencies – Factors Influencing Frequency, Empirical Formulae For Hull Frequency Estimation. Analytical Methods For Calculation Of Hull Modes ( Elementary Treatment Only ). The Stodala's Interpolation Method.

Propeller Exciting Forces. Damping – Types Of Damping. Special Local Vibration Problems – Rudder Vibration, Cavitation, Stress And Vibration Levels, Human Reaction To Vibration.

General Methods Of Reducing Vibrations. Devices For Reducing Main Hull Vibration. Synchronising Devices For Twin – Screw Ships, Rotating Weight Neutralisers, Kurt Nozzles.

*Reference Books:*


1. Strength Of Ship Structures By W. Muckle
2. Ship Construction By D.J. Eyers
3. Principles Of Naval Architecture By Ed.V. Lewis
4. Ship Design And Construction By R.Taggart


## V. CASD (COMPUTER AIDED SHIP DESIGN)

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Course Objective: To acquaint and equip with the computer aided design and manufacturing of farm machinery with the help of CAD.

Course outcomes: Successful achievement of master level outcomes is required to receive a passing grade in the course. .

* Ability to create fully constrained solid models that can be quickly modified using standard software tools.

* Ability to use, identify and explain standard features in solid modeling including protrusions, revolutions, cutouts, and patterns

* Ability to use standard software tools to create engineering drawings, or other documents, to fully describe the geometries and dimensions of parts, as well as to document assemblies according to standard practice

* Ability to use standard software tools to create part assemblies and check for clearances.

* Ability to create the drawings of farm implements and their analysis.

* Ability to write the CNC part programming

Fundamentals of CAD - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- windowing - clipping - 2D and 3D transformations - Linear transformation- Display files for 3D data - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

Introduction to Finite Element Analysis - CAD techniques to finite element data preparation- Automatic mesh generation- presentation of results - 3-dimensional shape description and mesh generation- CAD applications of FEM.

Database systems, structures, entity-relation models, Application to ship design, model manufacturing and testing, CAD applications in ship building, Computer aided manufacture, Numerical control, Part programming.

*Text Books:*

1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover & E.W.Zimmer.

2. Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.

*References:*

1. Computer Aided Design in Mechanical Engineering, by V.Rama Murthy.
2. Elements of Computer Aided Design & Manufacturing, by Y.C.Pao.
3. Computer Aided Kinetics for Machine Design, by D.L.Ryan.
4. Computer Aided Design and Manufacturing, by C.B.Besant & C.W.K.Lui.
5. Computer-Aided Analysis & Design by S. Ghosal, Prentice Hall of India.
6. CAD/CAM/CIM by Radhakrishna, New age international.

## VI. UNDER WATER ACOUSTICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Introduction Sound : Wave motion, Sound pressure, Reference intensity, Source level, Radiated power, Limitations to sonar power, Cavitation, Interaction, Changes to arrays, Projector sensitivity, Hydrophone sensitivity, Spectrum level, Sound in air and in sea water,

Arrays : Need for projector arrays, Need for hydrophone arrays, Beam patterns, Directivity of a dipole, The general line array, Shading, Shaded arrays: transmit source levels, Directivity index, Line array: beam pattern vs. steer angle, Broadside array: length and spacing, Beam pattern for a continuous line, DI of a simple dipole, DI of a line array, DI of a planar array, DI of a cylindrical array, DI formulae based for simple arrays, Conformal arrays, Spherical arrays, Volumetric arrays, Beam formers, Domes and arrays.

Propagation of Sound in the Sea : Propagation loss, Losses, Spreading losses, Absorption losses, Spherical spreading and absorption, Propagation in the real ocean, The speed of sound, Sound speed profiles, Deep sound channel, Reliable acoustic path, Surface duct propagation, Convergence zone propagation, Bottom bounce propagation, Propagation loss models, Ray theory and the Hodgson model, Hodgson example, Performance prediction, Multipath propagation

Target Strength : Definition, Formulae, Measurement, Dependence on pulse type and duration, TS of a sphere, TS of some simple shapes, TS of small targets, Mine target strength, Torpedo target strength, Submarine echoes, Beam aspect target strength, Bow aspect target strength, Submarine target strengths, Towed arrays, Target strength reduction, Practical values.

Noise in Sonar Systems : Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel, the sonar environment, Self-noise Electrical noise, Machinery noise, Flow noise, Propeller noise, Variation with speed, Variation with frequency, Directivity, Self-noise and radiated noise, Addition of noise levels, Receiver noise factor, Noise factor of a sonar, Acceptable receiver noise level, Alternative calculation, Practical values

Reverberation : Sources of reverberation, Scattering and reflection, Boundary roughness, Classes of reverberation, Backscattering strength, Reverberation target strength, Volume reverberation, Boundary reverberation, Scattering layers, Volume scattering strength, Sea surface scattering strength, Bottom scattering strength, Variation with fi-equency, Reverberation under ice.

The Sonar Equations : The basic sonar equation, The basic passive equation, The basic active equation, Detection threshold and detection index, Receiver operating characteristics, ROC curves,

Passive Sonar : Radiated noise, Radiated noise: source level, Nature of radiated noise, Practical values, Broadband and narrowband, Normalization, A Note on Swaths, Passive arrays, Passive aural, Passive displays, Formulae for detection threshold, Broadband square law detector, Broadband cross-correlator detector, Narrowband processor, Narrowband amplitude detector processor, Passive ranging, Triangulation, Vertical direct passive ranging, Horizontal direct passive ranging, Towed arrays, Bearing ambiguity, Self-noise,

Active sonar : Pulse types, Active sonar equations, Reverberation index, Reverberation and Target Echoes in the main lobe, and sidelobes, Range, pings and doppler shift, Reverberation rejection by CW pulses, Practical reverberation envelopes, Fulland half-beam processing, Beam forming, FM phase binning process, CW processing, Large aperture array, Detection performance, Noise and reverberation-limited detection ranges:, Ambiguity diagrams, Very long pulses, Operational degradation factor, Active displays, Unified detection and classification, Bandwidth, Beamwidth, CADAC, Levels of CADAC, CADAC and pulse features, Statistical analysis, Amplitude profiles, Multipath affects classification

*Textbook:*

Sonar for Practicing Engineers – A.D. Waite - Third Edition – John Wiley References:

1. Principles of Underwater Sound – (1983) Robert J Urick – Mc Graw Hill Publications

2. Understanding Active Noise Control C.H. Hansen

3. Underwater Acoustic Systems Rodney F.W. Coates

4. Underwater acoustics Leon Camp

## VII. SHIP CONSTRUCTION

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objective:***

• To be well versed in how to apply various knowledge of architecture on ship operations.

• To Understand Ship Stability and Statically Stability

***Course Outcome:***

* CO 01: To understand the types of Ships

* CO 02: To understand the Stress and Strain in Ships in Still water and in Sea way

* CO 03: To understand the principle part of Ships

* CO 04: To understand the advantages of welding over riveting

* CO 05: To understand the concept of law of floatation

* CO 06: To understand the center of buoyancy and factors affecting the same

* CO 07: To understand the Transverse Statically stability

* CO 08: To understand the Equilibrium of Ship

* CO 09: To calculate of List while Loading, Discharging and/or shifting weights, Correction of List

* CO 10: To understand how to use of hydrostatic tables and curves as supplied to ships, Displacement/draft-curve and table, Light displacement& Load displacement

Introduction to ship building and materials used: A typical ship construction program. Building berth. Building Dock. Multi-stage construction methods. Equipment used in building berths. Use of Goliath cranes. Floating Docks. Ship types. Shipyard layout. Classification societies, development and application of classification rules, role of statutory bodies. Materials for ship construction. Structural steels, special steels, non- ferrous steels, non-metallic materials, material properties and testing of materials. Joining methods of materials, non-destructive testing.

Storage and preparation of material and structural elements: Material handling and storage, transport system in steel stockyard, material preparation Devices- cleaning, marking processes. The cutting process, Mechanical cutting, thermal Cutting, optically and numerically controlled cutting, bending of rolled and built-up sections, Plate bending. Nesting of plates.

Fabrication of sub-assemblies, units and hull erection: Process of prefabrication, welding in prefabrication and erection stages, sub-assemblies, flat Sections, panels- flat and curved, double bottom sections, side tank units, fore-end and aftend Structures, deck and bulkhead structures. Assembly of hull-units. Erection of hull-units On building berth/dock.

Ship structural components: Functions and details of ship structural components, framing systems, single and double Bottom construction, shell and deck plating, bulkheads, pillars, girders and hatch-coaming, Machinery casings, super structures and deck- houses. Bow and stern Structures. Bossing and Struts, bilge keels and fenders. Out Fitting, Welding, Testing And Trials And Launching: Various components of outfitting, consisting of systems, equipment and fittings of hull, Machinery and electrical groups. Hull Preservation methods. Various outfitting methods.

Advanced outfitting. Methods of welding, metallurgy of welding weld defects, distortion and Stresses in welds, testing of welds. Inspection and testing during various stages of ship Construction. Testing of structures and tanks. Bollard tests and sea trials. Details of launching Arrangements.

*References:*

1. Merchant Ship Construction by D. A. Taylor

2. Ship Construction by D.J. Eyres

3. Ship Design and Construction by R.Taggart

## VIII. EXPERIMETAL HYDRODYNAMICS

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Course Objectives: To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

Course Outcomes: Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

Small Amplitude Wave Theory Formulation and Solution: Review of hydrodynamics-Boundary Value Problems, summary of two-dimensional

periodic water wave BVP, solution of linearized water wave BVP for a horizontal bottom, dispersion equation, engineering wave properties-water particle, kinematics of progressive waves, pressure field under a standard wave, partial standing waves, energy and energy propagation in progressive waves- principle of conservation of energy. Energy Flux.

Wave Forecasting: Generation of waves-theories of wave generation by Kelvin, Phillips, Milne, Jeffrey, Swerdrup and munk. Concept of fully developed sea, Characteristics of ocean waves, significant wave height and period, wave height variability, energy spectra of waves, simplified wave prediction models-SMB and PNJ. Methods, wave forecasting charts, effects of moving storms and variable wind speed and direction.

Wave Transformation and Wave statistics: Transformation of wave entering shallow water, shoaling of waves in shallow water, wave reflection, refraction and diffraction, combined refraction, diffraction, and wave breaking. Wave Height distribution-single wave train, wave groups, narrow banded spectra, Rayleigh's distribution, wave spectrum, directional wave spectrum-JONSWAP, PNJ and Bretschneider spectra.

Wave Forces: Wave forces on vertical cylindrical bodies due to non-breaking waves – Basic concepts, calculations of forces and moments, Transverse forces due to eddy shedding (Lift forces), selection of hydrodynamic force coefficient, $C_d$ and $C_m$, calculation of forces and moments on groups of vertical and non-vertical cylindrical bodies due to breaking and non-breaking waves.

*Text Book:*

1. Shore Protection Manual, Vols. 1 & 2 by US army coastal engineering research center publication

*Reference Books:*

1. Water Wave Mechanics by Dean and Dlrymple
2. An introduction to Hydrodynamics and Water Waves by B. Le Mehaute
3. Estuary and Coastline Hydrodynamics by A.T. Ippen

## IX. MARINE POWER PLANT ENGINEERING

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Introduction: Classification of Power Plants, Comparison between land based and Marine Power Plants Performance Characteristics of Marine Power Plants, Fuel Consumption under varying conditions, Marine Power Plants layout.

Marine boilers: Marine Boilers of Fire Tube, Composite and water-tube boilers. Feed water treatment. Feed water supply systems and controls.

Marine steam turbines: Construction details, Compounded steam turbines for Marine applications, Operation and maintenance.

Marine gas turbines: Gas Turbine cycles for Marine applications, Recent trends and developments, Free piston engines, Combined Cycle Plants.

Nuclear power plants: Nuclear fission reaction, types of reactors, Fuels, moderators, Coolants, Control and safety rods, radiation hazards and shielding, Radioisotope applications, Radioactive Waste disposal, Nuclear Powered propulsion, Indian reactor developments.

Marine Refrigeration and Air Conditioning: Marine refrigeration systems-operation and maintenance-application in modern passenger ships, bulk carriers and refrigerated vessels. Air conditioning systems on board the ships-temperature and humidity control-comfort conditioning. Cabin and cargo ventilation- piping and ducting-insulating materials

*Text books:*

1) Marine Power Plants — P.Akinov

2) Nuclear Engineering — D.K.Singhal

3) Marine Engineering — R.Harrington

4) Introduction to Marine Engineering — D.A.Taylor

## XI. MARINE ENGINEERING - I

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Marine Diesel Engines – Low speed and medium speed engines – Auxiliary engines – Scavenging and supercharging systems – Starting and reversing gear – Maintenance – Automation – Hazards in engine room.

Marine Nuclear power installation - Principles of operation of Atomic Reactors – Different types of Reactors – Use of Nuclear reactors in sea going vessels - Radiation hazards and safety – Radioactive waste disposal.

Marine Turbines – Steam turbine Classification based on impulse and reaction principles – Flow thro' blade passages and design – Losses and performance – Compounding, velocity triangles – Starting and Maintenance procedures.

Marine gas turbines – Practical cycles and shaft arrangements - Power turbine – Applications.

Marine Refrigeration – Cycles – Compressors, Condensers, Evaporators and thermostatic valves – Space coolers – Maintenance and Auxiliary equipment.

Marine Air-conditioning – cooling, Heating, Humidication process – Types of Air conditioning systems – Ducting controls.

Ventilation – Requirements and provision – Insulation protection of materials and maintenance.

Marine Boilers – Composite and water tube boilers – Waste heat boilers Arrangement of boiler room – Feed water treatment for Marine boilers – feed supply systems and control.

*Text Books:*

1. Marine Power plant Engineering - Akimov.P
2. Marine I.C Engines-A.B Kane
3. Principles and practice of Marine Diesel Engines – D.K Sanyal
4. Refrigeration and air-conditioning- P.L. Ballaney
5. Marine Steam Boilers- Milton J.H.

## XII HYDRO DYNAMICS AND COMPUTATIONAL METHODS

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Introduction and Basic Numerical Methods: Introduction to CFD, Approximation and interpolation, Numerical integration, Finite difference approximations of derivatives

The Finite Volume Method for Model Problems: 1-D diffusion, Thomas algorithm for tri-diagonal systems, 1-D convection-diffusion, 2-D model problems

Modeling Navier Stokes Equations: Governing equations for fluid mechanics, Staggered grids, Pressure-velocity coupling – the SIMPLE algorithm, Steady flows, Unsteady flows, Implementation of boundary conditions Commercial CFD codes, Reynolds averaged Navier-Stokes (RANS) equations and turbulence modeling

Text Books: 1. Introduction to CFD the finite volume method by Malalasekera & Versfeeg 2. Computational FM and heat transfer by Anderson, Tennehill and Pletchen

## HSS ELECTIVES

## ORGANIZATIONAL BEHAVIOUR

***Course Objectives:***

1. To understand the basic concepts of organisational behaviour, its foundations and importance.
2. To enable students to have a basic perspective of Motivation and Motivation theories.
3. To acquaint the students about group behaviour in organizations, including communication, leadership conflicts and organizational change and how these are linked to and impact organizational performance.

***Course Outcomes:***

1. Indentifying fundamental aspects of organizational dynamics.
2. Evaluate main theories of motivation and formulating suitable motivational strategies.
3. Analyze the behaviour of individuals and groups in organizations.
4. Understanding of Leadership theories and Leadership behaviour.
5. Apply relevant theories, concepts to address important Organizational Behaviour questions.

Organisational Behaviour : Concept of Organisation - Concept of Organisational Behaviour - Nature of Organisational Behaviour - Role of Organisational behaviour - Disciplines contributing to Organisational Behaviour.

Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation : Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and Mc Gregor's Theory X and Theory Y.

Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication : Downward, Upward and Horizontal communication.

Organisational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Interorganisational conflict - Conflict management.

Organisational Change: Nature - Factors inOrganisational change - Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

*Text Books.*

1.L.M.Prasad: Organisational Beaviour, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organisational Behaviour, Himalaya Publishing House, New Delhi

*Reference Books.*

1. Stephen Robbins: Organisational Behaviour, Pearsons Education, New Delhi.

## INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

***Course Objectives:***

* To familiarize the students with the concepts of Management.

* To relate the concepts of Management with industrial organizations.

* To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.

* To set forth a basic framework for understanding Entrepreneurship.

***Course Outcomes:***

On completion of the course, the students will be able to:

* Understand the roles, skills and functions of management.

* Distinguish the different types of business organizations.

* Identify the factors involved in Production Operations Management.

* Diagnose organizational problems and take suitable decisions.

* Establish good Human Resource Management practices.

* Acquire necessary knowledge and skills required for organizing and carrying out

* entrepreneurial activities.

Basic Concepts of Management: Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

*Text Books:*

(1 ) Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

(2) Vasant Desai, The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth),HImalayan Publishing House, 2018.

*Reference Books:*

(1) Aryasri , A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

(2) Sheela, P. , and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

## OPERATIONS RESEARCH

***Course Objectives:***

* Formulate a real world problem as a mathematical programming model.

* Provide knowledge of optimization techniques and approaches.

* Understand and study inventory problems.

* Know the network models.

* Put on knowledge in solving replacement problems and different queueing models

***Course Outcomes:***

* Learned to translate a real-world problem into a mathematical formulation.

* Formulate and Solve Transportation, Assignment and sequencing problems.

* Resolve inventory problems.

* Able to solve maximum flow and shortest path problems.

* Capable to solve replacement problems and analyze queueing models.

Introduction: Definitions of Operations Research; Phases of Operations Research; Types of Operations Research models; applications, merits and demerits of Operations Research.

Allocation: Linear Programming problem formulation; Basic assumptions; Graphical solution; Simplex method; Artificial variable technique; Two phase method; Big M method; Duality principle; Primal and Dual relation.

Transportation: Formulation; Solution methods; Unbalanced transportation problems - North west corner rule; Least cost entry method; Vogel's approximation method; Optimal solution; degeneracy.

Assignment: Formulation; Variations in Assignment problem; Travelling salesman problem.

Sequencing: Sequencing of - n jobs through two machines; n jobs through three machines; n jobs through m machines; 2 jobs through m machines.

Inventory Control: Introduction; Types of Inventory; Inventory costs; Deterministic models - Economic order quantity (EOQ) and Economic Production Quantity (EPQ) with and without shortages; Quantity discounts; P system; Q system; Inventory control Techniques.

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Replacement: Introduction, Replacement of items that deteriorate with time - Value of money unchanging and changing, Replacement of items that fail completely.

Queueing models: Introduction; Single channel poisson arrivals; Exponential service times; Unrestricted queue with infinite population and finite population models; Multi channel poisson arrivals; Exponential service times with infinite population and restricted queue.

*Text Books:*

1. Hamdy A Taha, "Operations Research- An Introduction" by TAHA , Prentice Hall, 2009.

2. F.S. Hiller, G.J. Liberman,B. Nag and P.Basu "Introduction To Operations Research, Mc Graw Hill Education(India), 2012.

3. S.D.Sharma, "Operations Research", Kedarnadh Ramnadh & Co.,2017

*Reference Books:*

1. R. Pannerselvam, "Operations Research", PHI..

2. Richard Bronson, Schaum's Series," Operations Research", Mc Graw Hill

3. N.V.S.Raju, "Operations Research- Theory and Practice" BS publications.

4. V.K. Kapoor, "Operations Research" Sultan Chand & Sons.

## MARINE ENGINEERING

SCHEME AND SYLLABI (with effect from 2021-22)

***B.Tech I Year - I Semester***

| Course code | Category | Course Title | Hours per week L | P | Internal Marks | External Marks | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| NM 1101 | BS | Mathematics – I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 1102 | BS | Physics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 1103 | ES | Engineering Graphics | 2 | 3 | 30 | 70 | 100 | 3 |
| NM 1104 | ES | Introduction to Physical oceanography | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 1105 | ES | Introduction to Naval Architecture | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 1106 | ES | Workshop | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 1107 | BS | Physics Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 1108 | ES | Ship Welding Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| | | Total Credits | | | | | | 19.5 |

***B.Tech I Year - II Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM1201 | BS | Mathematics – II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM1202 | BS | Chemistry | 4 | 0 | 30 | 70 | 100 | 3 |
| NM1203 | HSS | English | 4 | 0 | 30 | 70 | 100 | 3 |
| NM1204 | ES | Computer programming and Numerical Methods | 4 | 0 | 30 | 70 | 100 | 3 |
| NM1205 | ES | Basic Ship Theory | 4 | 0 | 30 | 70 | 100 | 3 |
| NM1206 | HSS | English Language Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM1207 | BS | Chemistry Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM1208 | ES | Computer programming and Numerical Methods Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| | | Total Credits | | | | | | 19.5 |

## B. Tech (Naval Architecture and Marine Engineering)

***B. Tech - II Year- I Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 2101 | BS | Mathematics - III | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2102 | PC | Engineering Mechanics – I (Statics) | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2103 | PC | Mechanics of Materials - I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2104 | PC | Basic Thermodynamics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2105 | HSS | Managerial Economics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2106 | PC | Computer Aided Ship Design Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 2107 | PC | Mechanics of Materials Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 2108 | PC | Ship Drawing - I | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 2109 | SC | DelftShip Software Practice | 1 | 2 | 50 | 50 | 100 | 2 |
| NM 2110 | MC | Professional Ethics & Universal | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Human Values | 0 | 0 | 0 | 100 | 100 | 0 |
| NM 2111 | MC | NSS/NCC | 0 | 2 | - | - | - | 0 |
| | | Total Credits | | | | | | 21.5 |

***B. Tech -II Year- II Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 2201 | ES | Electrical Technology | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2202 | BS/PC | Eng. Mechanics – II (Dynamics) | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2203 | PC | Mechanics of Materials - II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2204 | PC | Engineering Thermodynamics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2205 | PC | Material Science | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 2206 | PC | Electrical Tech Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 2207 | PC | AutoCAD Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 2208 | SC | Intellectual Property Rights | 1 | 2 | 50 | 50 | 100 | 2 |
| NM 2209 | MC | Environmental Science | 0 | 0 | 0 | 100 | 100 | 0 |
| | | Total Credits | | | | | | 20.0 |

Internship I

***B. Tech - III Year- I Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 3101 | PC | Fluid Mechanics | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3102 | PC | Ship Design - I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3103 | PC | Ship Construction | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3105 | PE | Professional Elective I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3104 | OE | Open Electives I | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3106 | PC | Marine Thermal Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3107 | PC | NAPA Lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3108 | SC | Welding Practice | 1 | 2 | 50 | 50 | 100 | 2 |
| NM 3109 | INT | Internship-I | | | 50 | 50 | 100 | 2 |
| | | Total Credits | | | | | | 22.0 |

***B. Tech -III Year- II Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 3201 | PC | Resistance and Propulsion | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3202 | PC | Strength of Ships | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3203 | PC | Ship Design - II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3204 | PE | Professional Elective II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3205 | OE | Open Electives II | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 3206 | PC | Marine Hydrodynamics Lab | 0 | 3 | 30 | 70 | 100 | 1.5 |
| NM 3207 | PC | Marine Instrumentation and Metrology lab | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3208 | PC | Ship Drawing - III | 0 | 3 | 50 | 50 | 100 | 1.5 |
| NM 3209 | SC | Soft Skills | 1 | 2 | 50 | 50 | 100 | 2 |
| | | Total Credits | | | | | | 21.5 |

Internship II

***B. Tech -IV Year- I Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 4101 | PE | Professional Elective III | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4102 | PE | Professional Elective IV | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4103 | PE | Professional Elective V | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4104 | OE | Open Electives III | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4105 | OE | Open Electives IV | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4106 | HSS | Elective | 4 | 0 | 30 | 70 | 100 | 3 |
| NM 4107 | SC | Advanced NAPA Lab | 1 | 2 | 50 | 50 | 100 | 2 |
| NM4108 | INT | Internship-II | | | 50 | 50 | 100 | 2 |
| | | Total Credits | | | | | | 22.0 |

***B. Tech -IV Year- II Semester***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM 4201 | PROJ. | Project work | | | 100 | 100 | 200 | 14 |
| | | Total Credits | | | | | | 14.0 |

## Professional Electives:

I. Intro to Offshore structures
II. Ocean Structures & materials
III. FEA
IV. Marine Manufacturing Technology
V. Fishing Vessel Technology
VI. Marine Hydrodynamics
VII. Advanced Welding Technology
VIII. sea keeping and maneuverability
IX. Dynamics of Offshore Structures
X. Design of Small Crafts
XI. Naval Vessels
XII. Advanced Ship Theory
XIII. Under Water Acoustics
XIV. Marine Engineering II
XV. Advanced Fluid Mechanics

## Open Electives:

I. Industrial Electronics
II. NAPA /Rhino /Exact Flat Lab
III. Marine Instrumentation and Control
IV. Ship Vibrations
V. CASD

VI. Underwater Acoustics

VII. Ship Construction

VIII. Experimental Hydrodynamics

IX. Marine Power plant Engineering

X. Sub Sea Piping

XI. Marine Engineering I

XII. Hydrodynamics and computational Methods

## HSS Electives

I. Organization Behavior

II. Industrial management and Entrepreneur

III. Operations Research

## B.Tech I Year - I Semester

## NM 1101 - MATHEMATICS-I

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

Course Objectives: The contents of this course fulfill the fundamental requirements of knowledge of Mathematics for learning Engineering subjects. The main objectives of student learning are:

* To transmit the knowledge of Partial differentiation.

* To know of getting maxima and minima of function of two variables and finding errors and approximations.

* To evaluate double and triple integrals, volumes of solids and area of curved surfaces.

* To expand a periodical function as Fourier series and half-range Fourier series.

Course Outcomes: At the end of this course, the student will understand and be able to apply the basic principles of differential and integral calculus to various engineering problems. Particularly, the student will be able to

* Find the partial derivatives of functions of two or more variables.

* Evaluate maxima and minima, errors and approximations.

* Evaluate double and triple integrals, volumes of solids and area of curved surfaces.

* To expand a periodical function as Fourier series and half-range Fourier series.

* Have a fundamental understanding of Fourier series and be able to give Fourier expansions of a given function. Partial Differentiation, Multiple Integrals, Fourier series and Their Applications

(Partial Differentiation) : Introduction - Functions of two or more variables - Partial derivatives - Homogeneous functions – Euler's theorem - Total derivative - Change of variables – Jacobins. Mean value Theorems (without proofs)

(Applications of Partial Differentiation) : Geometrical interpretation -Tangent plane and Normal to a surface -Taylor's theorem for functions of two variables - Errors and approximations -Total differential. Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers - Differentiation under the integral Sign - Leibnitz's rule.

(Multiple Integrals) : Introduction - Double Integrals - Change of Order of Integration - Double Integrals in Polar Coordinates - Triple Integrals - Change of Variables.

(Multiple Integrals-Applications) : Area enclosed by plane curves - Volumes of solids - Area of a curved surface - Calculation of Mass - Center of gravity - Moment of inertia - product of inertia – principal axes- Beta Function - Gamma Function - Relation between Beta and Gamma Functions. Error Function or Probability Integral.

(Fourier Series) : Introduction - Euler's Formulae - Conditions for a Fourier Expansion - Functions having points of discontinuity - Change of Interval - Odd and Even Functions - Expansions of Odd or Even Periodic Functions, Half-Range Series - Parseval's Formula. Practical Harmonic analysis.

*TEXT BOOK:*

Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd Edition, Khanna publishers.

*REFERENCE BOOKS:*

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K.International publishing house Pvt. Ltd.

2. Advanced Engineering Mathematics by Erwin Kreyszig.

3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.

4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.

5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company. Higher Engineering Mathematics by Dr. M.K.Venkataraman

## NM 1102- PHYSICS

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To impart knowledge in basic concept of physics of Thermodynamics relevant to engineering applications.

* To grasp the concepts of physics for electromagnetism and its application to engineering. Learn production of Ultrasonics and their applications in engineering.

* To Develop understanding of interference, diffraction and polarization: connect it to a few engineering applications.

* To Learn basics of lasers and optical fibers and their use in some applications.

* To Understand concepts and principles in quantum mechanics and Nanopahse Materials. Relate them to some applications.

***Course Outcomes:***

Upon successful completion of this course, the student will be able to:

* Understand the fundamentals of Thermodynamics and Laws of thermodynamics. Understand the working of Carnot cycle and concept of entropy.

* Gain Knowledge on the basic concepts of electric and magnetic fields. Understand the concept of the nature of magnetic materials. Gain knowledge on electromagnetic induction and its applications .

* Understand the Theory of Superposition of waves. Understand the formation of Newton's rings and the working of Michelson's interferometer. Remember the basics of diffraction, Evaluate the path difference. Analysis of Fraunhofer Diffraction due to a single slit

* Understand the interaction of matter with radiation, Characteristics of Lasers, Principle, working schemes of Laser and Principle of Optical Fiber. Realize their role in optical fiber communication.

* Understand the intuitive ideas of the Quantum physics and understand dual nature of matter. Compute Eigen values, Eigen functions, momentum of Atomic and subatomic particles using Time independent one Dimensional Schrodinger's wave equation. Understand the fundamentals and synthesis processes of Nanophase materials.

## SYLLABUS

THERMODYNAMICS : Introduction, Heat and Work, First law of thermodynamics and applications, Reversible and Irreversible process, Carnot cycle and Efficiency, Second law of thermodynamics, Carnot's Theorem, Entropy, Second law in terms of entropy, Entropy and disorder, Third law of thermodynamics (statement only).

ELECTROMAGNETISM : Concept of electric flux, Gauss's law - some applications, Magnetic field - Magnetic force on current, torque on current loop, The Biot-Savart's Law, B near a long wire, B for a circular Current loop, Ampere's law, B for a solenoid, Hall effect, Faraday's law of induction, Lenz's law, Induced magnetic fields, Displacement current, Maxwell's equations (no derivation), Magnetic materials: Classification of magnetic materials and properties.

Ultrasonics : Introduction, Production of Ultrasonics – Piezoelectric and Magnetostriction methods, acoustic grating, applications of ultrasonics.

OPTICS

Interference: Principles of superposition – Young's Experiment – Coherence - Interference in thin films (reflected light), Newton's Rings, Michelson Interferometer and its applications.

Diffraction: Introduction, Differences between interference and diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a single slit (Qualitative and quantitative treatment).

Polarisation: Polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization.

LASERS and FIBRE OPTICS : Introduction, characteristics of a laser beam, spontaneous and stimulated emission of radiation, population inversion, Ruby laser, He-Ne laser, Semiconductor laser, applications of lasers

Introduction to optical fibers, principle of propagation of light in optical fibers, Acceptance Angle and cone of a fibre, Numerical aperture, Modes of propagations, classification of fibers, Fibre optics in communications, Application of optical fibers.

MODERN PHYSICS : Introduction, De Broglie concept of matter waves, Heisenberg uncertainty principle, Schrodinger time independent wave equation, application to a particle in a box. Free electron theory of metals, Kronig - Penney model (qualitative treatment), Origin of energy band formation in solids, Classification of materials into conductors, semi conductors and insulators.

Nanophase Materials : Introduction, properties, Top-down and bottom up approaches, Synthesis - Ball milling, Chemical vapour deposition method , sol-gel methods, Applications of nano materials.

*TEXT BOOKS :*

1. Physics by David Halliday and Robert Resnick – Part I and Part II - Wiley.

2. A textbook of Engineering Physics, Dr. M. N. Avadhanulu, Dr. P.G. Kshirsagar - S. Chand

3. Engineering Physics by R.K. Gaur and S.L. Gupta –Dhanpat Rai

*Reference Books:*

1. Modern Engineering Physics by A.S. Vadudeva

2. University Physics by Young and Freedman

## NM 1103- ENGINEERING GRAPHICS

Periods/week :5 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

The main objectives of the course are to

CEO1. Understand the basics of Engineering Graphics and BIS conventions.

CEO2. Develop the graphical skills for communication of concepts, ideas and design of engineering products through technical drawings

CEO3 Demonstrate and practice the various profiles/curves used in engineering practice through standard procedures.

CEO4. Demonstrate and practice the orthographic projections of points, lines, planes, solids and section of solids

CEO5. Demonstrate and practice the development of surfaces of simple solids

CEO6. Familiarize the basic concept of isometric views clearly.

***Course Outcomes:***

After completion of the course, the student will be able to

CO1. Develop simple engineering drawings by considering BIS standards.

CO2. Able to draw different engineering curves with standard Procedures

CO3. Comprehend the basics of orthographic projections and deduce orthographic projections of points, lines, planes and solids at different orientations in real life environment.

CO4. Visualize clearly the sections of solids.

CO5. Apply the concepts of development of surfaces while designing/ analyzing any product.

CO6. Recognize the significance of isometric drawing to relate 2D environment with 3D environment.

### SYLLABUS

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions, and Scales.

Curves: Conic sections: General construction of ellipse, parabola and hyperbola. Construction of involutes of circle and polygons only. Normal and tangent to curves.

Projections of Points: Principal or Reference Planes, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane.

Projections of Straight Line Inclined to Both the Reference Planes: Projections of Planes: Projection of Perpendicular planes: Perpendicular to both reference planes, perpendicular to one reference plane and parallel to other reference plane and perpendicular to one reference plane and inclined to other reference plane. Projection of Oblique planes. Introduction to Auxiliary Planes.

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to other and axes inclined to both the reference planes.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids (Prism, Pyramid, Cylinder and Cone) in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

Isometric Views: Isometric projection, Isometric scale and Isometric view. Isometric view of Prisms, Pyramids, cylinder, cone, and their combinations.

*Text Book:*

Elementary Engineering Drawing by N.D.Bhatt, Charotar Publishing House.

*Reference:*

Engineering Graphics by K.L. Narayana and P. Kannaiah, Tata Mc-Graw Hill

## NM1104 Introduction to Physical Oceanography

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

Physical properties of seawater: Temperature, Salinity and Density distributions. Transparency of seawater, Sound in the sea, Light in the sea, Colour of seawater, Sea Ice. Measurement of Temperature and salinity With Depth.

Waves: wave parameters, deep water waves, shallow water waves, transformation of waves in shallow water, wave generation and dissipation.

Tides: Tide producing forces, Types of tides, tidal theories. major tidal constituents-prediction of tides

Water masses: T-S diagram, Characteristics of water masses, Deep circulation water masses, Major water masses of the world oceans.

Ocean circulation: Wind induced currents, Upwelling, sinking; equatorial current system, warm and cold currents of major world ocean, seasonal

currents in North Indian Ocean, west ward intensification of currents.

Coastal processes: Transformation of waves– refraction, construction of refraction diagram, diffraction, reflection. Coastal and near shore circulation-long shore currents, rip currents and tidal currents.

Beach features: Beach cycles, beach profiles-erosion and accretion, Sediment transport rate – onshore and offshore transport – coastal features – LEO observation

Beach stability – artificial nourishment – coastal defence structures – planning and design of coastal structures – tidal inlets and Lakes, deltas.

Estuaries: Classification, tides in estuaries, estuarine circulation and mixing, Hydrology and hydrograph, sedimentation in estuaries

Marine geology: Continental shelf, Slope, Shelf sediments, submarine topography, mid oceanic ridge system, gas hydrates, manganese nodules.

Marine biology: Classification of marine environment, Biogeochemical cycles. Influence of Physical parameters (Temperature, salinity, waves, currents, tides etc.). Nitrogen, Phosphorus and Silica controls, Residence time of elements in sea water. Marine Ecosystem: Mangroves, Coral Reefs.

*Text Books:*

1. Introduction to Physical oceanography by M.P.M.Reddy.

2. Introduction to Physical oceanography by Robert.H.Stewart.

3. Introduction to dynamical oceanography by S.Pond and G.L.Pickard.

## NM 1105 INTRODUCTION TO NAVAL ARCHITECTURE

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

History – Development of primitive floating vehicles / platforms. Evolution of ship types; evolution of materials used in ship construction. Contribution of the ships to civilisation, trade and discovery of the planet Earth.

Fundamentals of Floatation - Archimedes principle, laws of floatation and stability. Classification of ships and other Marine platforms. Definition and general arrangement of typical ships and Marine platforms.

Ship terminology and their meaning. Ship lines and procedure to draw them. Introduction to ship construction / production process. Visit to Shipyard.

Economics of waterway transportation. Domain of Naval Architecture Studies and role of a Naval Architect. Challenges and state of the art.

Avenues for a Naval Architect.

*Text Book:*

Introduction to Naval Architecture by Eric Tupper- Butterworth Heinemann Publications

## NM 1106- WORKSHOP

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

Course Objectives: The engineering work shop practice is included to introduce some common shop practices and on hands on experience to appreciate the use of skill, tools, equipment and general practices to all the engineering students. This laboratory course is aimed to provide the practical exposure to the students in the fields of Carpentry, Fitting, Sheet Metal and house electrical wiring works to

* Get hands on experience with the working skills in Carpentry trade.

* Know how to work with Sheet Metal tools.

* Get familiar with the working skills of Metal Fitting operations.

* Get hands on experience with house hold electrical wiring.

Course Outcomes: By the end of this laboratory, the student

* Can be able to work with Wood Materials in real time applications.

* Can be able to build various parts with Sheet Metal in day-to-day life.

* Can be able to apply Metal Fitting skills in various applications.

* Can be able to apply this knowledge to basic house electrical wiring and repairs.

Carpentry: Any three jobs from – Half lap joint, Mortise and Tenon joint, Half – lap Dovetail joint, Corner Dovetail joint, Central Bridle joint.

Sheet Metal: Any three jobs from – Square tray, Taper tray(sides), Funnel, Elbow pipe joint.

Fitting: Any three jobs from – Square, Hexagon, Rectangular fit, Circular fit and Triangular fit.

House wiring: Any three jobs from – Tube light wiring, Ceiling fan wiring, Stair-case wiring, Corridor wiring.

*References:*

1. Elements of workshop technology, Vol.1 by S. K. and H. K. Choudary.

2. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.

3. Engineering Practices Lab Manual, Jeyapoovan, Saravana Pandian, 4/e Vikas.

## NM 1107-PHYSICS LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives:***

This subject is common to all first year branches of UG engineering. At the end of the course the student is expected to

* To enable the students to acquire skill, technique and utilization of the Instruments

* Draw the relevance between the theoretical knowledge and to imply it in a practical manner with respect to analyze various electronic circuits and its components.

* To impart the practical knowledge in basic concepts of Wave optics, Lasers and Fiber optics.

* To familiarize the handling of basic physical apparatus like Vernier callipers, screw gauge, Spectrometers, travelling microscope, laser device, optical fibre, etc.

***Course Outcomes:***

* Ability to design and conduct experiments as well as to analyze and interpret

* Ability to apply experimental skills to determine the physical quantities related to Heat, Electromagnetism and Optics

* The student will learn to draw the relevance between theoretical knowledge and the means to imply it in a practical manner by performing various relative experiments.

***List of Experiments:***

1. Determination of Radius of Curvature of a given Convex Lens By forming Newton's Rings.
2. Determination of Wavelength of Spectral Lines in the Mercury Spectrum by Normal Incidence method.
3. Study the Intensity Variation of the Magnetic Field along axis of Current Carrying Circular Coil.
4. Determination of Cauchy's Constants of a Given Material of the Prism using Spectrometer.
5. Determination of Refractive Index of Ordinary ray $m_o$ and Extraordinary $m_e$ ray.
6. Determination of Thickness Given Paper Strip by Wedge Method.
7. Calibration of Low Range Voltmeter.
8. Calibration of Low Range Ammeter.
9. Determination of Magnetic Moment and Horizontal Component of Earth's Magnetic Field.
10. Lees Method - Coefficient of thermal Conductivity of a Bad Conductor.
11. Carey Foster's Bridge – Verification of laws of Resistance and Determination Of Specific Resistance.
12. Melde's Apparatus – Frequency of electrically maintained Tuning Fork.
13. Photoelectric cell-Characteristics.
14. Planks Constants.
15. Laser- Diffraction.

## NM 1108 SHIP WELDING LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***LIST OF EXPERIMENTS:***

(Practical/hands on)

1. Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Lap Joints)
2. Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Butt Joints)
3. Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(T-joint)
4. Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Flange Joints)

***Study Experiments (Theoretical)***

5. Spot welding and Spot Welding safety
6. TIG welding TIG welding safety.
7. Plasma welding and Plasma welding safety.
8. Submerged welding and Submerged welding safety.

## B.Tech I Year - II Semester

## NM 1201- MATHEMATICS-II

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

Course Objectives: The contents of this course fulfill the fundamental requirements of knowledge of Mathematics for learning Engineering subjects. The main objectives of student learning are:

* The way of obtaining rank, eigen values and eigen vectors of a matrix.

* To know the importance of Cayley-Hamilton theorem and getting canonical form from a given quadratic form.

* To solve the system of equations by using direct and indirect methods.

* To solve first order and higher order differential equations by various methods.

* To obtain the Laplace transforms and inverse Laplace transforms for a given functions and their applications.

Course Outcomes: At the end of this course, the student will understand and be able to apply the basic principles of Linear Algebra, ODEs and Laplace Transforms to various engineering problems. Particularly, the student will be able to

* Find rank, eigen values and eigen vectors of a matrix and understand the importance of Cayley-Hamilton theorem.

* Reduce quadratic form to canonical forms and solving linear systems by direct and indirect methods.

* Demonstrate solutions to first order differential equations by various methods and solve basic applications problems related to electrical circuits, orthogonal trajectories and Newton's law of cooling

* Discriminate among the structure and procedure of solving higher order differential equations with constant and variable coefficients.

* Understand Laplace transforms and its properties and finding the solution of ordinary differential equations.

## SYLLABUS

Matrix Algebra, Ordinary Differential Equations and Laplace Transforms

(Linear Algebra) : Rank of a matrix- Echelon form, Normal Form - Solution of Linear System of Equations - Consistency of Linear System of Equations - Direct & Indirect Methods: Gauss elimination method, LU Factorization method, Gauss Seidal Method. Complex Matrices: Hermitian, Skew-Hermitian and Unitary Matrices and their Properties.

(Eigen Values and Eigen Vectors) : Eigen Values and Eigen Vectors of a Matrix - Cayley-Hamilton theorem - Inverse and Powers of a Matrix using Cayley-Hamilton's theorem and its applications. Diagonalization of a Matrix - Quadratic Forms - Reduction of Quadratic Form to Canonical Form - Nature of a Quadratic Form.

(Ordinary Differential Equations of First Order and its Applications) : Formation of ordinary differential equations (ODEs) - Solution of an ordinary differential equation - Equations of the first order and first degree - Linear differential equation - Bernoulli's equation - Exact differential equations - Equations reducible to exact equations - Orthogonal Trajectories - Simple Electric (LR & CR) Circuits - Newton's Law of Cooling - Law of Natural growth and decay.

(Differential Equations of Higher Order) : Solutions of Linear Ordinary Differential Equations with Constant Coefficients - Rules for finding the complimentary function - Rules for finding the particular integral - Method of variation of parameters - Cauchy's linear equation - Legendre's linear equation - Simultaneous linear differential equations.

(Laplace Transforms) : Introduction - Existence Conditions - Transforms of Elementary Functions - Properties of Laplace Transforms - Transforms of Derivatives - Transforms of Integrals - Multiplication by $t^n$ - Division by t – Evaluation of integrals by Laplace Transforms - Inverse Laplace Transform - Applications of Laplace Transforms to Ordinary Differential Equations - Simultaneous Linear Differential Equations with Constant Coefficients - Second Shifting Theorem - Laplace Transforms of Unit Step Function, Unit Impulse Function and Laplace Transforms of Periodic Functions.

*TEXT BOOK:*

Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43$r^d$ edition, Khanna publishers.

*REFERENCE BOOKS:*

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K. International publishing house Pvt. Ltd.

2. Advanced Engineering Mathematics by Erwin Kreyszig.

3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal. Lakshmi Publications.

4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.

5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.

## NM 1202 – Chemistry

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To apply the basic knowledge of Chemistry to the Engineering Discipline.

* To develop knowledge about water and its treatment for industrial and potable purposes.

* To develop understanding in the areas of Polymers, Mechanism of Corrosion of Metals and Corrosion Control Methods, Fuels, Lubricants and Nanomaterials for of conducting polymers, bio-degradable polymers and fiber reinforced plastics and apply the knowledge for solving existing challenges faced in various engineering and societal areas.

***Course outcome:***

* This course applies the basic concepts and principles studied in Chemistry to Engineering.

* It provides an application of chemistry to different branches of engineering

* The students will be able acquire knowledge in the areas of Water Chemistry,Polymers, Corrosion, Fuels and Lubricants and nanomaterials and suggest innovative solutions for existing challenges in these areas.

Water Chemistry : Sources of Water – Impurities and their influence of living systems – WHO Limits – Hardness and its Determination – Boiler Troubles and their removal – Water Softening Methods – Lime-Soda, Zeolite and Ion Exchange - Municipal Water Treatment-Break Point Chlorination – Desalination of Sea Water – Reverse Osmosis Method, Electro-dialysis.

Polymers and Plastics : Polymers: Definition – Types of Polymerization (Addition & Condensation) – Mechanisms of Addition Polymerization – Radical and Ionic – Thermodynamics of Polymerization Process. Plastics: Thermosetting and Thermoplastics – Effect of Polymer Structure on Properties of Cellulose Derivatives – Vinyl Resins – Nylon (6,6), Reinforced Plastics – Conducting Polymers.

Corrosion : Corrosion: Origin and Theory – Types of Corrosion: Chemical and Electrochemical; Pitting, Inter granular, Waterline, Stress – Galvanic Series – Factors Effecting Corrosion.

Corrosion Controlling Methods: Protective Coatings: Metallic Coatings, Electroplating and Electroless Plating – Chemical conversion Coatings – Phosphate, Chromate, Anodized, Organic Coatings – Paints and Special Paints.

Fuels and Lubricants : Solid Fuels: Wood and Coal, Ranking of Coal – Analysis (Proximate and Ultimate) Coke Manufacture – Otto Hoffmann's Process – Applications; Liquid Fuels: Petroleum Refining – Motor Fuels – Petrol and Diesel Oil – Knocking – Octane number – Cetane Number; Gaseous Fuels: Biogas, LPG and CNG – Characteristics – Applications; Rocket Fuels: Propellants – Classification – Characteristics

Lubricants: Classification – Mechanism – Properties of Lubricating Oils – Selection of Lubricants for Engineering Applications.

Nanomaterials : Nanomaterials, Properties and application of fullerenes, fullerols, Carbon nanotubes and nanowires. Synthesis - Top-down and Bottom-up approaches - Nanocomposites - Nanoelectronics- Applications of nanomaterials in catalysis, telecommunication and medicine.

*Text Books:*

1. Engineering Chemistry – PC Jain and M. Jain – Dhanpath Rai and Sons, New Delhi.

2. A Text book of Engineering Chemistry – S. S. Dara – S. Chand & Co. New Delhi.

*Reference Books:*

1. Engineering Chemistry – B. K. Sharma – Krishna Prakashan – Meerut.

2. Introduction to Nanoscience - S. M. Lindsay - Oxford University Press

3. Engineering Chemistry - B. L. Tembe, Kamaluddin and M. S. Krishnan, (NPTEL).

## NM 1203 – ENGLISH

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To make students understand the explicit and implicit meanings of a text/topic;

* To give exposure to new words and phrases, and aid to use them in different contexts;

* To apply relevant writing formats to draft essays, letters, emails and presentations; and

* To adapt oneself to a given situation and develop a functional approach to finding solutions: adaptability and problem solving.

***Course Outcomes:***

* Students will be able to analyse a given text and discover the various aspects related to language and literature;

* Learn the various language structures, parts of speech and figures of speech;

* Develop one's reading and writing abilities for enhanced communication; and

* Learn to apply the topics in real-life situations for creative and critical use.

### SYLLABUS

Reading: On the conduct of life: William Hazlitt

Grammar: Prepositions

Vocabulary: Word Formation I: Introduction to Word Formation

Writing: Clauses and Sentences

Life skills: Values and Ethics

If: Rudyard Kipling

Reading: The Brook: Alfred Tennyson

Grammar: Articles

Vocabulary: Word Formation II: Root Words from other Languages

Writing: Punctuation

Life skills: Self-Improvement

How I Became a Public Speaker: George Bernard Shaw

Reading: The Death Trap: Saki

Grammar: Noun-Pronoun Agreement, Subject- Verb Agreement

Vocabulary: Word Formation III: Prefixes and Suffixes

Writing: Principals of Good Writing

Life skills: Time Management

On saving Time: Seneca

Reading: ChinduYellama

Grammar: Misplaced Modifiers

Vocabulary: Synonyms, Antonyms

Writing: Essay Writing

Life skills: Innovation

Muhammad Yunus

Reading: Politics and the English Language: George Orwell

Grammar: Clichés, Redundancies

Vocabulary: Common Abbreviations

Writing: Writing a Summary

Life skills: Motivation

The Dancer with a White Parasol: Ranjana Dave

Text Book: Language and Life: A Skills Approach Board of Editors, Orient Blackswan Publishers, India. 2018.

*Suggested Readings*

1. Practical English Usage, Michael Swan. OUP. 1995.

2. Remedial English Grammar, F.T. Wood. Macmillan.2007

3. On Writing Well, William Zinsser. Harper Resource Book. 2001

4. Study Writing, Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

5. Communication Skills, Sanjay Kumar and PushpLata. Oxford University Press. 2011.

6. Exercises in Spoken English, Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

## NM 1204-Computer programming and numerical Methods

Periods/week :4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* The course is designed to provide complete knowledge of C language.

* To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.

* To provide knowledge to the Students to develop logics which will help them to create programs, applications in C.

* This course aims to identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.

* This course provides the fundamental knowledge which is useful in understanding the other programming languages.

***Course Outcomes:***

* Identify basic elements of C programming structures like data types, expressions, control statements, various simple functions and Apply them in problem solving.

* Apply various operations on derived data types like arrays and strings in problem solving.

* Design and Implement of modular Programming and memory management using Functions, pointers.

* Apply Structure, Unions and File handling techniques to Design and Solve different engineering programs with minimal complexity.

* Apply Numerical methods to Solve the complex Engineering problems.

### SYLLABUS

1. Introduction to C: Basic structure of C program, Constants, Variables and data types, Operators and Expressions, Arithmetic Precedence and associativity, Type Conversions. Managing Input and Output Operations Formatted Input, Formatted Output.

2. Decision Making, Branching, Looping, Arrays & Strings: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statement, the else..if ladder, switch statement, the (?:) operator, the GOTO statement., The while statement, the do statement, The for statement, Jumps in Loops ,One, Two-dimensional Arrays, Character Arrays. Declaration and initialization of Strings, reading and writing of strings, String handling functions, Table of strings.

3. Functions: Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions: No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Values. Nesting of functions, recursion, passing arrays to functions, passing strings to functions, the scope, visibility and lifetime of variables.

4. Pointers: Accessing the address of a variable, declaring pointer variables, initializing of pointer variables, accessing variables using pointers, chain of pointers, pointer expressions, pointers and arrays, pointers and character strings, array of pointes, pointers as function arguments, functions returning pointers, pointers to functions, pointers to structures-Program Applications

5. Structure and Unions: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, arrays of structures, arrays within structures, structures within structures, structures and functions and unions, size of structures and bit-fields- Program applications.

6. File handling: Defining and opening a file, closing a file, Input/ Output operations on files, Error handling during I/O operations, random access to files and Command Line Arguments- Program Applications

7. Numerical Methods: Solutions of Algebraic and Transcendental Equations, Bisection Method, Newton Raphson Method. Newton's forward and backward Interpolation, Lagrange's Interpolation in unequal intervals. Numerical Integration: Trapezoidal rule, Simpson's 1/3 rules. Solutions of Ordinary First Order Differential Equations: Euler's Method, Modified Euler's Method and Runge-Kutta Method.

*Text Book:*

1. Programming in ANSI C, E Balagurusamy, 6th Edition. McGraw Hill Education (India) Private Limited.

2. Introduction to Numerical Methods, SS Sastry, Prentice Hall

*Reference Books:*

1. Let Us C ,YashwantKanetkar, BPB Publications, 5th Edition.

2. Computer Science, A structured programming approach using C", B.A.Forouzan and R.F.Gilberg, " 3rd Edition, Thomson, 2007.

3. The C –Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.

4. Scientific Programming: C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

## NM 1205 Basic Ship Theory

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

### SYLLABUS

Introduction: Archimedes principle, principles of flotation, types of ships, nomenclature and geometry. Lines plan, and fairing of lines, displacement and tonnage, TPC, coefficients of forms, wetted surface area. Calculation of area, volume, and first and second moments using Simpson's rule, center of gravity, effect of addition of mass, movement of mass and suspended mass.

Stability of ships and freeboard: Transverse stability of ships, statical stability at small angles of heel, calculation of BM, metacentric diagram, free surface effect, Inclining experiment, Bonjean curves, hydrostatic curves. Stability at large angles: Statical Stability Curve, angle of loll, wall sided formula, cross curves of stability, polar diagrams, metacentric evolute, particular cases of righting moment, dynamical stability, stability diagrams, effects of external heeling moments, stability criteria.

Trim and effects of changes in draught. Free board, Different types of free board, ships types based on free board, ILLC requirements, freeboard calculations.

Subdivision of ships: Causes and types flooding, volume and surface permeability due to bilging of side compartments. Added weight and buoyancy, methods of calculation, subdivision load lines, margin line, floodable length, permissible length, flood able length curves.

Launching: Launching arrangement, end launching, side launching, launching calculations, docking and grounding.

*Text Book:*

Introduction to Basic Ship Theory- Butterworth Heinemann Publications

## NM 1206- ENGLISH LANGUAGE LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives:***

* To make students recognize the sounds of English through Audio-Visual aids;

* To help students build their confidence and help them to overcome their inhibitions and self- consciousness while speaking in English;

* To familiarize the students with stress and intonation and enable them to speak English effectively; and

* To give learners exposure to and practice in speaking in both formal and informal contexts.

***Course Outcomes:***

* Students will be sensitized towards recognition of English sound patterns and the fluency in their speech will be enhanced;

* A study of the communicative items in the laboratory will help students become successful in the competitive world;

* Students will be able to participate in group activities like roleplays, group discussions and debates; and

* Students will be able to express themselves fluently and accurately in social as well professional context.

Introduction to Phonetics: The Sounds of English (Speech sound – vowels and consonants) - Stress and Intonation - Accent and Rhythm.

Listening Skills: Listening for gist and specific information - listening for Note taking, summarizing and for opinions - Listening to the speeches of eminent personalities.

Speaking Skills: Self-introduction - Conversation Skills (Introducing and taking leave) - Giving and asking for information - Role Play - Just A Minute (JAM) session - Telephone etiquette.

Reading and Writing skills: Reading Comprehension – Précis Writing - E-Mail writing - Punctuation.

Presentation skills: Verbal and non-verbal communication - Body Language - Making a Presentation.

*Reference Books:*

1. Ashraf Rizvi. Effective Technical Communication. Tata McGraw Hill Education Private Limited, New Delhi.

2. Speak Well. Orient Blackswan Publishers, Hyderabad.

3. Allan Pease. Body Language. Manjul Publishing House, New Delhi.

## NM 1207- CHEMISTRY LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives:***

* To develop the fine skills of quantitative determination of various chemical components through titrimetric analysis

* To prepare and use ion exchange/ zeolite columns for the removal of hardness of water

* To develop the skill of organic synthesis through the preparation of a polymer/ drug

***Course Outcomes:***

* The course provides quantitative determine the amount of various chemical species in solutions by titrations and conduct the quantitative determinations with accuracy

* The course provides to develop novel materials to be used as zeolite and prepare columns for removal of hardness of water

* The course provides to synthesise a polymer or a drug

***List of Experiments***

1. Determination of Sodium Hydroxide with HCl ($Na_2CO_3$ Primary Standard)
2. Determination of Alkalinity (Carbonate and Hydroxide) of water sample
3. Determination of Fe(II)/Mohr's Salt by Permanganometry
4. Determination of Oxalic Acid by Permanganometry
5. Determination of Chromium (VI) by Mohr's Salt Solution
6. Determination of Zinc by EDTA method
7. Determination of Hardness of Water sample by EDTA method
8. Determination of Chlorine in water by Iodometric Titration
9. Ionexchange/ Zeolite column for removal of hardness of water
10. Synthesis of Polymer/ drug

*Reference Books:*

1. Vogel's Quantitative Chemical Analysis – V – Edition – Longman.

2. Experiments in Applied Chemistry (For Engineering Students) – Sinita Rattan – S. K. Kataria & Sons, New Delhi

## NM1208- NM Computer programming and numerical Methods Lab

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives:***

* To impart writing skill of C programming to the students and solving problems.

* To write and execute programs in C to solve problems such as Modularize the problems into small modules and then convert them into programs.,

* To write and execute programs in C to solve problems such as arrays, files, strings, structures and different numerical methods.

* This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Objective-C Programming languages.

***Course Outcomes:***

* Understand various computer components, Installation of software. C programming development environment, compiling, debugging, and linking and executing a program using the development environment.

* Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs.

* Construct programs that demonstrate effective use of C features including arrays, strings, structures, pointers and files.

* Apply and practice logical ability to solve the real world problems.

* Apply Numerical methods to Solve the complex Engineering problems.

### SYLLABUS

1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?

2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while).

3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, Copying one string to another, Reversing a string, adding one string to another.

4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int, long, float, and double. What happens when you add 1 to the largest possible integer number that can be stored?

5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.

6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).

7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.

8. Given two points on the surface of the sphere, write a program to determine the smallest arc length between them.

9. Implement bisection method to find the square root of a given number to a given accuracy.

10. Implement Newton Raphson method to det. a root of polynomial equation.

11. Given table of x and corresponding f(x) values, Write a program which will determine f(x) value at an intermediate x value by using Lagrange's interpolation/

12. Write a function which will invert a matrix.

13. Implement Simpson's rule for numerical integration.

14. Write a program to solve a set of linear algebraic equations.

## B. Tech (Naval Architecture and Marine Engineering)

### B. Tech - II Year- I Semester

### NM 2101 MATHEMATICS – III

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

CEOS : In general, the students are introduced with a knowledge on the topics: Vector Calculus, Partial differential equations, their applications and Integral Transforms (Fourier transforms, FST, FCT) so as to facilitate them to use these concepts in core subjects.

THE OBJECTIVES, IN PARTICULAR ARE TO LEARN:

* The basic knowledge and applications of Vector Calculus used in Engineering problems.

* About the gradient, divergence and curl under the differentiation of scalar and vector point functions, also on Line-, Surface- and Volume integrals under the integration of point functions along with their applications in Engineering issues.

* Transformation theorems such as Green's theorem in the plane, Stoke's theorem, Gauss Divergence theorem and their applications.

* How to formulate the Partial Differential Equations from the relation between the dependent and independent variables, the methods of solving first order first degree linear, non-linear Partial Differential Equations, Homogeneous and Non homogeneous linear partial differential equations with constant coefficients .

* The procedure to find out the solutions of Partial Differential Equations by using the method of separation of variables (product method) about the formulation of one dimensional wave (string equation), one-and two-dimensional Heat flow equations, Laplace's equation in Cartesian and polar coordinates, and how to solve these equations using the method of separation of variables.

* The concept of integral transforms, namely, Fourier transforms, Fourier Sine, Cosine and related inverse transforms, and their applications in solving several Physical and Engineering problems.

COS

* After going through this course , the students would be able to:

* Operate the differential operator 'del' to the scalar and vector point functions, Calculate the Gradient, Divergence and Curl, Vector normal to a surface, maximum rate of change of a scalar field, test whether two surfaces are to cut orthogonally or not .

* find the rate per unit volume at which the physical quantity is issuing from a point, the rate of inflow minus out flow using the Divergence and the angular velocity of rotation at any point of the vector field using the Curl.

* Test whether the given motion is irrotational or rotational, whether a vector force acting on a particle is conservative or not

* find out the potential function from a given vector field.

* obtain the well known Laplace and poisson equations from an irrotational field

* understand to determine the work done by a force field and circulation using a Line integral

* find out the Line, Surface and Volume integrals, find flux using surface integral and volumes using the volume integral.

* apply the vector integral theorems ( Green's theorem in the plane, Stoke's and Divergence theorems) for evaluating the double and triple integrals as these are used to find areas and volumes.

* know the methods of solving Linear and Non linear first order and first degree partial differential equations.

* solve the Linear Partial Differential Equations with constant coefficients (homogeneous and non homogeneous) and know the procedure for finding the complementary function and particular integrals

* apply the method of separation of variables to obtain solutions to the boundary value problems involving Linear partial differential equations occurred in engineering studies

* solve wave equation, heat flow equation and the Laplace's equations in Cartesian and polar coordinates using the method of separation of variables.

* apply and extend the knowledge of Fourier transform techniques in solving several Initial and Boundary value problems of Engineering, such as in Conduction of heat / Thermodynamics, Hydraulics transverse vibrations of a string, oscillations of an elastic beam, bending of beams, electrical circuits, free and forced vibrations of a membrane and transmission lines , etc.

VECTOR CALCULUS-DIFFERENTIATION

Differentiation of vectors, curves in space, velocity and acceleration, relative velocity and relative acceleration, scalar and vector point functions, vector operator Ñ applied to scalar point functions- gradient, Ñ applied to vector point functions- divergence and curl. Physical interpretation of gradient, divergence and culrl (i.e., $\nabla f, \nabla.\bar{F}, \nabla\times\bar{F}$), Irrotational and Solenoidal fields, the relations obtained after Ñ applied twice to point functions, applied to products of two functions.

LO-1: To obtained knowledge on Differentiation of vectors and also to solved problems on vector Calculus

VECTOR INTEGRATION: Integration of vectors, line integral, circulation, work done, surface integral-flux, Green's theorem in the plane, Stoke's theorem, volume integral, Gauss Divergence theorem. (All theorems without proofs)

Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates

LO-2: : To find out the as many as coordinates and the application of various theorems.

PARTIAL DIFFERENTIAL EQUATIONS : Formation of partial differential equations, solutions of partial differential equations- equations solvable by direct integration, linear equations of first order: Lagrange's Linear equation, non-linear equations of first order, Charpit's method. Homogeneous linear equations with constant coefficients- rules for finding the complementary function, rules for finding the particular integral (working procedure), non-homogeneous linear equations.

LO-3: To solve linear equations of first order and also o solve non-homogenous linear equations.

APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS : Method of separation of variables, One dimensional wave equation-vibrations of a stretched string, one dimensional Heat flow equation, Two dimensional heat flow in steady state - solution of Laplace's equation in Cartesian and polar coordinates (two dimensional).

LO-4: To find the various applications of partial differential equations in two dimensional heat flow in steady state.

INTEGRAL TRANSFORMS (Fourier Transform) : Introduction, definition, Fourier integral, Sine and Cosine integrals, Complex form of Fourier integral, Fourier transform, Fourier Sine and Cosine transforms, Finite Fourier Sine and Cosine transforms, properties of Fourier transforms.

Convolution theorem for Fourier transforms, Parseval's identity for Fourier transforms, Fourier transforms of the derivatives of a function, simple applications to Boundary value problems.

LO-5 To obtained knowledge on Fourier series and on Fourier transforms.

*TEXT BOOKS:*

Scope and treatment as in "Higher Engineering Mathematics", by Dr. B.S.Grewal, 43rd Edition, Khanna Publishers.

*REFERENCE BOOKS:*

1. Graduate Engineering Mathematics by V B Kumar Vatti, I.K.International publications

2. Advanced Engineering Mathematics by Erwin Kreyszig.

3. A text book of Engineering Mathematics by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.

4. Mathematical Methods of Science & Engineering aided with MATLAB by Kanti B.Dutta, Cengage Learning India Pvt. Ltd.

5. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw Hill Company.

6. Advanced Engineering Mathematics by H.K.Dass. S.Chand Company.

## NM 2102 ENGINEERING MECHANICS-I (STATICS)

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

Course Educational Objectives

* The objectives of the course are

* To teach the student how to determine the resultant force and moment for a given force system.

* To Teach the student how to Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.

* To Teach the student how to determine the centroid and second moment of area

* To Teach the student the method of Virtual Work for the solution of Engg Mechanic problems

***Course outcomes:***

* At the end of the course, the student will be able to:

* Determine the resultant force and moment for a given force system.

* Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction.

* Determine the centroid and second moment of area

* Learn the method of Virtual Work for the solution of Engg Mechanic problems

## SYLLABUS

General Principles : Fundamental concepts, Units of Measurement, SI Units

LO-1:

* To provide an introduction to the basic quantities and idealizations of mechanics.

* To give a statement of Newton's Laws of Motion and Gravitation.

* To present a general guide for solving problems.

Force Vectors. Vector Operations, vector addition of forces, Coplanar forces, Cartesian vectors, Position vectors, Force vector directed along a line, dot product

LO-2:

* To show how to add forces and resolve them into components using the Parallelogram Law.

* To express force and position in Cartesian vector form and explain

* To introduce the dot product in order to determine the angle between two vectors or the projection of one vector onto another

Equilibrium of a Particle Condition for the equilibrium of a particle, coplanar force system, Three-dimensional force systems

LO-3

* To introduce the concept of the free-body diagram for a particle.

* To show how to solve particle equilibrium problems using the equations of equilibrium.

Force System Resultants Moment of a force, scalar and vector formulation, principle of moments, moment of a force about a specified axis, moment of a couple, equivalent system, resultants of a force and couple system, further reduction of force and couple systems, distributed loading

LO-4:

* To provide a method for finding the moment of a force about a specified axis.

* To define the moment of a couple.

Equilibrium of a Rigid Body Conditions for equilibrium of a rigid body, free body diagrams, equations of equilibrium, two and three force members, equilibrium in 3-D, constraints for a rigid body

LO-6:

* To introduce the concept of the Equilibrium of a Rigid body.

* To show how to solve Rigid body equilibrium problems using the equations of equilibrium.

Structural Analysis Simple Trusses, method of joints, zero force members, method of sections, space trusses, frames and machines

LO-7:

* To solve problems on Simple Trusses

* To show how to solve problems on Frames and machines

Friction Characteristics of dry friction, problems involving dry friction, wedges, screws, flat belts

LO-8 :

* To introduce the concept of friction and to solve problems in dry friction.

Center of Gravity and Centroid Centre of gravity, centre of mass, centroid, composite bodies, pappus Guldinus theorem, distributed loading resultants.

LO-9:

* To introduce the concept of Centroid, Center of gravity and center of mass.

Moments of Inertia MI, parallel axis theorem, MI of area by integration, MI of composite areas, product of inertia, Mass MI

LO-10:

* To Derive MI of various composite areas and composite bodies.

Virtual Work Principle of VW for particle and rigid body, and system of connected bodies, conservative forces, PE, PE criterion for equilibrium, stability of equilibrium

LO-11

* To introduce the concept of Principal of Virtual Work

*Text Book:*

R C Hibbeler, “Engineering Mechanics – Statics and Dynamics- 14th Edition,” Pearson

*References:*

1. Vector Mechanics for Engineers: Statics and Dynamics, by Ferdinand P. Beer & E. Russell Johnston Jr., McGraw Hill

2. Engineering Mechanics by S. P. Timoshenko and D.H.Young, Mc.Graw-Hill.

3. Engineering Mechanics Statics and Dynamics 4thed Irving H Shames, Prentice Hall

## NM 2103 MECHANICS OF MATERIALS – I

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To provide the student with an understanding of Stress and Strain, thermal stresses, Mohr’s circle for the solution of stress in 2-D

* To teach the student regarding the structural elements like trusses and frames and their analyses

* Teach the student to Draw the BM and SFD

* To determine the deflection in beams subjected to various loadings

* To understand the concept of Torsion and evaluate the stresses in shafts and springs

***Course Outcomes***

* At the end of the course the student will be able to

* Calculate the state of stress including thermal stresses.

* Design structural elements like trusses and frames and beams

* Determine the state of stress in beams and the deflection of beams.

* Design shafts and springs

## SYLLABUS

General concepts: stress, strain, lateral strain, stress-strain diagram. Generalisation of Hooke’s law. Temperature stresses. Stresses in axially loaded bars. Strain energy Impact loads. Relation between elastic constants.

Stress transformation: Transformation of stresses in 2-D problems. Principal stresses in 2-d problems. Maximum shear stresses in 2-d problems. Mohr’s circle for stress transformation and principal stresses.

LO-1: Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tridimensional elastic solids

Bending moments and shear forces: Types of beams, Types of loads, Types of supports. S.F. and B.M. diagrams for statically determinate beams. Relation between bending moment, shear stress and intensity of loading.

Lo-2: Calculate and represent the stress diagrams in bars and simple structures Stresses in beams: Simple theory of bending, Flexural formula, Shear stress in beams. Principal stresses in beams.

Deflection of beams: Relation between curvature, slope and deflection. Double integration method.

Torsional stresses in shafts: Analysis of torsional stresses, power transmitted by circular shafts. Combined bending and torsion. Principal stresses in shafts.

LO-3: Solve problems relating to pure and non-uniform bending of beams and other simple structures Closed and opened coiled helical springs: Analysis of principal stresses in open and closed coiled helical springs. Thin walled cylindrical and spherical vessels: Analysis of stresses and strains.

LO-4: Understand the concept of buckling and be able to solve the problems related to isolated bars

*Text Books:*

Engineering mechanics of solids by E.P.Popov,second edition ,PHI.

*References:*

1. Mechanics of solids by R.C.Hibbler.
2. Analysis of structures by Vazirani and Ratwani Vol 1,1993 edition.

## NM 2104 : BASIC THERMODYNAMICS

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* The objectives of the course is to teach the student Fundamental concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat.

* The various laws of thermodynamics so that he can analyze systems like boilers,heat pumps, refrigerators, heat engines, compressors and nozzles.

* Evaluate the performance of vapour power cycles.

***Course Outcomes:***

At the end of the course, the student will be able to:

* Understand the concepts of continuum, system, control volume, thermodynamic properties, thermodynamic equilibrium, work and heat.

* Apply the laws of thermodynamics to analyze boilers, heat pumps, refrigerators, heat engines, compressors and nozzles.

* Evaluate the performance of vapor power cycles.

## SYLLABUS

Introduction: Basic concepts- Thermodynamic systems, Micro & Macro systems- Homogeneous and heterogeneous systems- Pure substance- Thermodynamic equilibrium, State Property, Path, Process- Reversible and irreversible cycles- Energy as a property of the systems

LO-1: To explain fundamental thermodynamic properties

Thermodynamic Laws: Zeroth law _First law - Corollaries- Isolated systems and steady flow systems- Specific heats - First law applied to flow systems- Systems undergoing a cycle and change of state- First law applied to steady flow processes- Limitations of first law of thermodynamics.

LO-2: Derive and discuss the first and second laws of thermodynamics

Second law- Kelvin Plank statement and Classius statement and their equivalence, Corollaries- PMM 1 & PMM 2 - Reversibility and irreversibility- Causes of irreversibility- Carnot cycle- Heat engines and heat pumps- Carnot efficiency- Classius theorem- Classius inequality- Concept of entropy

LO-3: Analyse basic thermodynamic cycles.

Properties of steam: Use of steam tables- Measurement of dryness fraction- T-S and H-S diagrams.

Vapor Power Cycles: Vapor power cycle- Rankine cycle- Reheat cycle and Regenerative cycles- Improvements of efficiency. Binary vapor power cycle.

LO-4: To improve the knowledge on various power cycle.

Steam Nozzles: Type of nozzles- Flow through nozzles- Condition for maximum discharge- Nozzle efficiency- Super saturated flow in nozzles- Steam injectors.

Steam Turbines: Classification of steam turbines- Impulse turbine and reaction turbine- Compounding in turbines- Velocity diagrams in impulse and reaction turbines- Degree of reaction- Condition for maximum efficiency of reaction turbines

Condensers: Classification of condensers - Sources of air leakage in condensers- Condenser efficiency

LO-5: To Explain velocity diagrams in turbines.

*Text Books:*

1. Engineering Thermodynamics, by P.K.Nag, Tata McGraw Hill Publications company.

2. Thermodynamics (SI Version) by William Z Black & James G Hartley

3. Thermal Engineering, by M.L.Mathur and F.S.Mehta, Jain Brothers.

*References:*

1. Thermodynamics, by Spalding and Cole.

2. Engineering Thermodynamics Work and Heat Transfer, by G.F.C.Rogers and Y.R.Mathew, ELBS publication.

3. Fundamentals of Engineering Thermodynamics By E Radhakrishnan

## NM 2105 MANAGERIAL ECONOMICS

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To bring about an awareness about the nature of Managerial Economics and its linkages with other disciplines.

* To understand the Micro and Macro Environment of Business.

* To familiarize the prospective engineers with the concepts and tools of Managerial Economics with an objective to understand the real world of business.

***Course Outcomes:***

* After completion of the course, student will be able to:

* Understand the various economic activities in business and industry.

* Analyse the real world business problems.

* Make optimal business decisions for the effective and efficient management of Organisations.

## SYLLABUS

Significance of Economics and Managerial Economics: Economics: Definitions of Economics- Wealth, Welfare and Scarcity definitions Classification of Economics- Micro and Micro Economics.

LO-1: To know the basic fundamentals of Economics : Managerial Economics: Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines.

LO-2: To know about Managerial Economics : Demand and Utility Analysis: Demand - Definition, Meaning, Nature and types of demand, Demand function, Law of demand - Assumptions and limitations. Exceptional demand curve.

LO-3: To understand the concept of Demand Elasticity of demand - Definition, Measurement of elasticity, Types of Elasticity (Price, Income, Cross and Advertisement), Practical importance of Price elasticity of demand, Role of income elasticity in business decisions, Factors governing Price Elasticity of demand.

LO-4: To obtained the knowledge on Elasticity of demand Utility Analysis: Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, The law of Diminishing Marginal Utility and its Limitations.

LO-5 : To know the concept of Utility Analysis Theory of Production and Cost analysis: Production - Meaning, Production function and its assumptions, use of production function in decision making;

Cost analysis - Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. Unavoidable costs, Economies and Diseconomies of scale.

LO-6: To know the Theory of Production and Cost analysis.

Market Structures : Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly , Oligopoly, Importance of kinked demand curve ;Monopolistic Competition.

Pricing and Business Cycles: Pricing Analysis : Pricing – Significance; Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing , Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

LO-7: To know the concept of Pricing and Business Cycles.

Business cycles - Definition, Characteristics, Phases, Causes and Consequences; Measures to solve problems arising from Business cycles.

*Text Books:*

1. Sankaran,S., Managerial Economics, Marghan Publications, 2015, Chennai.

2. Aryasri, A.R., Managerial Economics and Financial Analysis, MC Graw Hill Education, New Delhi,2015.

*Reference Books:*

1. Dwivedi, D.N., Managerial Economics, Vikhas Publishing House Pvt. Ltd. 6th Edition, New Delhi,2004.

2. Dewett, K.K., Modern Economic Theory, S.Chand & Company Ltd., New Delhi, 2005.

## NM 2106 COMPUTER AIDED SHIP DESIGN LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives***

* The objectives of the course are to provide training and provide hands on experience to the students on CAD software

***Course Outcomes***

* At the end of the course, the student will be in a position to model a ship using the softare

## SYLLABUS

CASD experiments:

1. Initiating the graphics package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.

2. Drawing of primitives (line, arc, circle, ellipse, triangle etc.)

3. Drawing a flange.

4. Drawing a Bushing assembly.

5. Dimensioning the drawing and adding text.

6. Setting the layers and application of the layers.

7. Isometric and orthographic projections.

8. Viewing in Three dimensions.

9. Removal of hidden lines - Shading and rendering

## NM 2107 – MECHANICS OF MATERIALS LAB

Periods/week : 3 Ses. : 50 Exam : 50
Examination Practical: 3hrs Credits: 1.5

***List of Experiments:***

1. To study the stress strain characteristics (tension and compression) of metals by using UTM.

2. To study the stress strain characteristics of metals by using Hounsefield Tensometer.

3. Determination of compression strength of wood.

4. Determination of hardness using different hardness testing machines- Brinnels, Vickers and Rockwell's.

5. Impact test by using Izod and Charpy methods.

6. Deflection test on beams using UTM.

7. Tension shear test on M.S. Rods.

8. To find stiffness and modulus of rigidity by conducting compression tests on springs.

9. Torsion tests on circular shafts.

10. Bulking of sand.

11. Punch shear test, hardness test and compression test by using Hounsefield tensometer.

12. Sieve Analysis and determination of fineness number.

## NM 2108 SHIP DRAWING – I

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

Theory

Lines plan: Drawing instruments and other equipment uses. Delineation of lines plan, Drawing of lines plan, Drawing of ship lines from basic Naval Arch Principles. Drawing of ship lines using series data. Special features and characteristics of ship lines. Mathematical representation of ship lines. Computer aided drawing and design. Use of scales and fairing of ship lines. Capacity calculations, capacity plan, scales, Bonjean curves, sectional area curves and their properties.

Practical: Lines plan, capacity plan, Bonjean curves, sectional area curves, special features of ship drawing tables, paper, area curves, tracing paper, pencil drawing and ink tracing techniques. Drawing of curved lines with battens, types of battens. Dos and Don'ts while using battens. Use of French curves and paper strips for fairing lines.

## NM 2109 : DELFTSHIP SOFTWARE PRACTICE

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 2

***Course Objectives***

* The objectives of the course are to provide training and provide hands on experience to the students on Delftship software for the purpose of hydrostatic calculations and resistance calculations

***Course Outcomes***

* At the end of the course, the student will be in a position to model a ship using the softare

* perform a detailed hydrostatic calculation

* Obtain the ship resistance

***Detailed Syllabus***

Delftship Main window features, Project Settings, Hull Modelling, Hydrostatic Calculations, Design Hydrostatics, Hydrostatics, Resistance, Report writing and explanation

## NM2110 PROFESSIONAL ETHICS AND UNIVERSAL HUMAN VALUES

***Course Objectives:***

* The objective of the course is Six fold:

* Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

* This course will illuminate the students in the concepts of laws and its applicability to engineers

* Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

* Strengthening of self-reflection, Development of commitment and courage to act and also enable the students to imbibe and internalize the Values and Ethical Behaviour in the personal and professional lives

* To enable the students to imbibe the Values and Ethical Behavior in the personal and Professional lives

* The students will learn the rights and responsibilities Individual, employee, team member and a global citizen

***Course Outcomes:***

* By the end of the course Student will be able to:

* Grasp the meaning of the concept – Law and also Get an overview of the laws relating to Engineers and also Apprehend the importance of being a law abiding person and They would have better critical ability

* Self-explore by using different techniques to live in harmony at various levels

* Analyze themselves and understand their position with respect to the moral and ethical character needed for a successful and satisfactory work life

* Students are expected to become more aware of themselves and their surroundings (family, society, nature)

* They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

* They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society

### SYLLABUS

Need, Basic Guidelines, Content and Process for Value Education Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation - as the process for self-exploration, Continuous Happiness and Prosperity - A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility - the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking, Include practice sessions and case studies.

LO-1: To know about Need, Basic Guidelines, Content and Process for Value Education Understanding Harmony in the Human Being - Harmony in Myself! Understanding human being as: a co-existence of the sentient 'I' and the material 'Body', the needs of Self ('I') and 'Body' - happiness and physical facility, the Body as an instrument of 'I' (I being the doer, seer and enjoyer), the characteristics and activities of 'I' and harmony in 'I', the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, ensure Sanyam and Health, Include practice sessions and case studies.

LO-2: To provide knowledge on Understanding Harmony in the Human Being Understanding Harmony in the Family and Society - Harmony in Human – Human Relationship Understanding values in human-human relationship: meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, the meaning of Trust; Difference between intention and competence, the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, the harmony in the society (society being an extension of family), Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order from family to world family, Include practice sessions and case studies.

LO-3: To Understanding Harmony in the Family and Society, Harmony in Human and Human Relationship Understanding Harmony in the Nature and Existence - Whole existence as Coexistence Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all – pervasive space, Holistic perception of harmony at all levels of existence, Include practice sessions and case studies.

LO-4: To Understanding Harmony in the Nature and Existence - Whole existence as Coexistence Concept of Law and Law of Torts Understanding Essentials of a Valid Contract and the basics of contract law protecting rights and obligations, Introduction to the Law of Torts and the basics to protect oneself and the company Law affecting the Workplace Employers Responsibilities/Duties Hiring Practices, Introduction to Intellectual Property Law, Professional Code of Conduct for Engineers, Relationship between Law and Ethics, Include practice sessions and case studies.

LO-5: To know the Concept of Law and Law of Torts Implications of the above Holistic Understanding of Harmony on Professional Ethics Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems, Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Include practice sessions and case studies.

LO-6: To Provide basic Implications of the above Holistic Understanding of Harmony on Professional Ethics

*Text Books*

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

3. R. Subramanian, "Professional Ethics", Oxford University Press.

4. S.B. Srivasthva, "Professional Ethics & Human Values", SciTech Publications (India) Pvt. Ltd. New Delhi.

5. D.R. Kiran, "Professional Ethics & Human Values", TATA Mc Graw Hill Education.

6. Saroj Kumar, "Business Law" and Avtar Singh, "Law of Contract"

*Reference Books*

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.

2. A. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.

3. The Story of Stuff (Book), Mohandas Karamchand Gandhi "The Story of My Experiments with Truth", E. FSchumacher. "Small is Beautiful", Slow is Beautiful –Cecile Andrews, J C Kumarappa "Economy of Permanence", Pandit Sunderlal "Bharat Mein Angreji Raj" and Dharampal, "Rediscovering India

4. G K Kapoor, "Business Law" and Sen & Mitra, "Business & Commercial Laws" and Calvin Frank Allen, "Business law for Engineers"

5. Hilgard, E. R.; Atkinson, R. C. & Atkinson, R.L. (1975). Introduction to Psychology. 6th Edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

6. Govindarajan, M; Natarajan, G. M. & Senthilkumar, V.S. (2013). Professional Ethics & Human Values. Prentice Hall: New Delhi

7. Gogate, S. B. (2011). Human Values & Professional Ethics. Vikas Publishing: New Delhi.

8. Charles E Harris Jr., Michael S Pritchard, Michael J Rabins, "Engineering Ethics, Concepts Cases: 4e, Cengage learning, 2015.

9. Caroline Whitbec, " Ethics in Engineering Practice & Research: 2e, Cambridge University Press 2015.

## NM 2111 NSS/NCC

## B. Tech -II Year- II Semester

## NM 2201 ELECTRICAL TECHNOLOGY

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.

* Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.

* To explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.

* Highlight the importance of transformers in transmission and distribution of electric power.

***Course Outcomes:***

* On completion of the course students will be able to

* Predict the behavior of electrical and magnetic circuits.

* Formulate and solve complex AC, Dc circuits.

* Identify the type of electrical machine used for that particular application.

* Realize the requirement of transformers in transmission and distribution of electric power and other applications

### SYLLABUS

Magnetic Circuits: Definitions of magnetic circuit, Reluctance, Magneto motive force (m.m.f.), Magnetic flux, Simple problems on magnetic circuits, Hysteresis loss. (Chapter-8, Pages 155-175).

LO-1: Understand the fundamentals of e.m.f, potential difference, current, resistance and energy conversions from one form to another

Electromagnetic Induction: Faraday's laws of Electromagnetic induction, Induced E.M.F., Dynamically induced E.M.F., Statically induced E.M.F., Self inductance, Mutual inductance. (Chapter-9, Page 176-190).

LO-2: Understand the basics of magnetic circuits and Identify the relationship between current and magnetic fields with application to determination of inductance

D.C. Generators: D.C. generator principle, Construction of D.C. generator, E.M.F. equation of D.C. generator, Types of D.C. generators, Armature reaction, Losses in D.C. generator, Efficiency, Characteristics of D.C. generators, Applications of D.C. generator. (Chapter-10, 11, Pages 208-238).

LO-3: Apply the concept of electromagnetism to understand Generator operation and interpret the relationship between charge and electric fields with its application.

D.C. Motors: D.C. motor principle, Working of D.C. motors, Significance of back E.M.F., Torque equation of D.C. motors, Types of D.C. motors, Characteristics of D.C. motors, Speed control methods of D.C. motors, Applications of D.C. motor. Testing of D.C. machines: Losses and efficiency, Direct load test and Swinburne's test. (Chapter-12,13, Pages 239-267).

LO-4: Analyze D. C. circuits, interpret relationship between voltage, current and power, examine concept of resonance, and analyze balanced three phase circuits.

A.C. Circuits: Introduction of steady state analysis of A.C. circuits, Single and balanced 3-phase circuits. (Chapter-16, pages 323-348).

Transformers: Transformer principle, EMF equation of transformer, Transformer on load, Equivalent circuit of transformer, Voltage regulation of transformer, Losses in a transformer, Calculation of efficiency and regulation by open circuit and short circuit tests. (Chap-20, p 423-455).

LO-5: Apply the concept of electromagnetism to understand Transformer operation and interpret the relationship between charge and electric fields with its application

Three Phase Induction Motor: Induction motor working principle, Construction of 3-phase induction motor, Principle of operation, Types of 3-phase induction motor, Torque equation of induction motor, Slip-torque characteristics, Starting torque, Torque under running condition, Maximum torque equation, Power stages of induction motor, Efficiency calculation of induction motor by direct loading. (Chapter-21, pages 463-489).

LO-6: Analyze and solve D. C. networks by applying various laws and theorems.

Alternator: Alternator working principle, EMF equation of alternator, Voltage regulation by sync. impedance method. (Chapter-23, pages 505-515).

Synchronous Motor: Synchronous motor principle of operation, Construction, Methods of starting of synchronous motor. (Chapter-24, pages 516-526).

Electrical Measurements: Principles of measurement of current, voltage, power and energy, Types of Ammeters, Voltmeters, Watt-meters, Energy meters, Electrical conductivity meter, Potentiometer, Megger.

LO-7: Solve problems on principles of measurement.

*Text Book:*

Elements of Electrical Engineering and Electronics by V.K. Mehta, S. Chand & Co.

*Reference:*

First Course in Electrical Engineering by Kothari.

## NM 2202 ENGINEERING MECHANICS – II (DYNAMICS)

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

Course Objectives:

The objectives of the course are

* To introduce the concepts of position, displacement, velocity, and acceleration

* To analyze the accelerated motion of a particle using the equation of motion with different coordinate systems.

* To develop the principle of work and energy

* To study the conservation of linear momentum for particles.

* To introduce the concept of angular impulse and momentum.

* To discuss applications of these equations to bodies undergoing translation, rotation about a fixed axis, and general plane motion.

* To show how the conservation of energy can be used to solve rigid–body planar kinetic problems.

* To apply the principles of linear and angular impulse and momentum to solve rigid-body planar kinetic problems that involve force, velocity, and time.

***Course Outcomes***

At the end of the course the student will be in a position to

* Understand the concepts of position, displacement, velocity, and acceleration

* Analyze the accelerated motion of a particle

* Solve problems in kinetics using Newton's Second law as well as principle of work and energy and conservation of linear momentum and angular momentum for particles

* Write the equations on motion for a plane body in translation, rotation about a fixed axis, and general plane motion.

* Use various techniques to solve kinetic problems in Plane motion.

## SYLLABUS

Kinematics of a Particle

Introduction. Rectilinear Kinematics: Continuous Motion. Rectilinear Kinematics: Erratic Motion. General Curvilinear Motion. Curvilinear Motion: Rectangular Components. Motion of a Projectile. Curvilinear Motion: Normal and Tangential Components. Curvilinear Motion: Cylindrical Components. Absolute Dependent Motion Analysis of Two Particles. Relative-Motion Analysis of Two Particles Using Translating Axes.

LO-1: Ability to form the relation between displacement, velocity and acceleration Kinetics of a Particle: Force and Acceleration Newton's Laws of Motion. The Equation of Motion. Equation of Motion for a System of Particles. Equations of Motion: Rectangular Coordinates. Equations of Motion: Normal and Tangential Coordinates. Equations of Motion: Cylindrical Coordinates. Central-Force Motion and Space Mechanics.

LO-2: Ability to form the equilibrium equations under dynamic forces, to calculate the unknowns of the equations, to determine the motion of the body

Kinetics of a Particle: Work and Energy The Work of a Force. Principle of Work and Energy. Principle of Work and Energy for a System of Particles. Power and Efficiency. Conservative Forces and Potential Energy. Conservation of Energy

Kinetics of a Particle: Impulse and Momentum Principle of Linear Impulse and Momentum. Principle of Linear Impulse and Momentum for a System of Particles. Conservation of Linear Momentum for a System of Particles. Impact. Angular Momentum. Relation Between Moment of a Force and Angular Momentum. Angular Impulse and Momentum Principles.

LO-3: To know the knowledge of Impulse and Momentum Planar Kinematics of a Rigid Body Rigid-Body Motion. Translation. Rotation About a Fixed Axis. Absolute General Plane Motion Analysis. Relative-Motion Analysis: Velocity. Instantaneous Center of Zero Velocity. Relative-Motion Analysis: Acceleration. Relative-Motion Analysis Using Rotating Axes.

LO-4: To provide the basic knowledge on Instantaneous center. Planar Kinetics of a Rigid Body: Force and Acceleration Moment of Inertia. Planar Kinetic Equations of Motion. Equations of Motion: Translation. Equations of Motion: Rotation About a Fixed Axis. Equations of Motion: General Plane Motion.

Planar Kinetics of a Rigid Body: Work and Energy Kinetic Energy. The Work of a Force. The Work of a Couple. Principle of Work and Energy. Conservation of Energy.

LO-5: To Solve problems on principle of work and enegy Planar Kinetics of a Rigid Body: Impulse and Momentum Linear and Angular Momentum. Principle of Impulse and Momentum. Conservation of Momentum. Eccentric Impact.

Lo-6: To provide the knowledge on kinetics of a rigid Body.

*Text Book:*

R C Hibbeler, "Engineering Mechanics – Statics and Dynamics- 14th Edition," Pearson

*References:*

1.Vector Mechanics for Engineers: Statics and Dynamics, by Ferdinand P. Beer & E. Russell Johnston Jr., McGraw Hill

2.Engineering Mechanics by S. P. Timoshenko and D.H.Young, Mc.Graw-Hill.

3.Engineering Mechanics Statics and Dynamics 4thed Irving H Shames, Prentice Hall

## NM 2203 : MECHANICS OF MATERIALS – II

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course objectives:***

* To provide basic knowledge in mechanics of materials so that the students can solve real engineering problems and design engineering systems.

* Analyze and design components and structural members subjected to tension, compression, torsion, bending and combined loads using fundamental concepts of stress, strain, elastic and inelastic behavior.

***Course Outcomes:***

* Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tridimensional elastic solids.

* Calculate and represent the stress diagrams in bars and simple structures Solve problems relating to pure and non-uniform bending of beams and other simple structures.

* Solve problems relating to torsional deformation of bars and other simple tri-dimensional structures.

* Understand the concept of buckling and be able to solve the problems related to isolated bars.

### SYLLABUS

Statically indeterminate Beams : Fixed Beams: Fixing moments of a fixed beam of uniform cross section. Effect of sinking of supports, Slope and deflection.

Continuous beams : Analysis of continuous beams ,Reaction at the supports, Effect of sinking of supports. B.M. and S.F. diagrams.

LO-I: To solve problems on Fixed beams and Continuous Beams and Analyze a statistically indeterminate structure.

Columns and struts : Introduction, Examples of instability, Criteria for stability of equilibrium. Euler's buckling theory –columns with pinned ends, Columns with different end restraints, Limitations of Euler's formulae. Column carrying eccentric loads, Empirical formulae.

LO-2: To calculate Euler's formulae for the end conditions of the column

Bending of curved bars : Stresses due to bending of curved bars of circular, rectangular and trapezoidal sections, curved bars subjected to eccentric loads such as crane hook.

LO-3: To Analysis the stresses due to curved bars of various geometric sections.

Thick cylinders : Subjected to internal and external pressure cylinders.

Theories of failure: Application to design of shafts.

LO-4: To Calculate Pressure in cylinders.

*Text Books :*

1. Engineering mechanics of solids by E.P.Popov,second edition ,PHI.
2. Mechanics of solids by R.C.Hibbeler.
3. Strength of materials by L.B.Shah and DrR.T.Shah

## NM 2204 ENGINEERING THERMODYNAMICS

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course objectives:***

* To develop the student's ability to apply the principles of thermodynamics to the optimal design of the basic energy conversion systems: power generation, refrigeration, air-conditioning, and combustion.

* To develop the student's ability to use thermodynamic relations and the property tables and charts for the analysis of energy conversion systems in the course of their operation.

* To provide the students with some knowledge and analysis skills associated with the principles and techniques of the design of energy conversion systems.

* To develop the student's ability to communicate effectively the knowledge of thermodynamics and energy conversion systems

***Course Outcomes***

* Students will demonstrate an ability to apply thermodynamic principles to the design, analysis, and optimization of the basic energy conversion systems: power generation, refrigeration, air-conditioning, and combustion.

* Students will demonstrate an ability to use thermodynamic relations and the physical property tables and charts for the analysis of gas and vapor power mixtures, phase transformations, chemical reactions, and combustions processes.

* Students will demonstrate an ability to apply the first and the second laws of thermodynamics to the analysis and optimization of the power generation, refrigeration, air-conditioning, combustion, and gas flow processes.

* Students will demonstrate an ability to determine engineering design quantities and estimate their effects on the basic performance characteristics of the energy conversion systems.

* Students will demonstrate an ability to communicate effectively the knowledge of thermodynamic principles, energy balance equations, and the use of the physical property tables and charts for the analysis of the energy conversion systems.

## SYLLABUS

I.C. engines: classification, comparison of two stroke and four stroke engines, comparison of S.I. and C.I. engines. Air cycles- Otto, Diesel, Dual, Sterling, Ericson and Atkinson cycles and their analysis. Valve timing and port timing diagrams Various Efficiencies. Basic principles of carburetion and fuel injection.

LO-1: To Understand the various engine components : Combustion in I.C. Engines: S.I. engines- Normal combustion and abnormal combustion- Importance of flame speed and effect of engine variables, types of abnormal combustion pre-ignition and knock, Fuel requirements and fuel rating, anti-knock additions- Combustion chamber requirements and Types of combustion chamber

LO-2: To demonstrate an ability to use thermodynamic relations and the physical property tables and charts for the analysis of gas and vapor power mixtures, phase transformations, chemical reactions, and combustions processes

Reciprocating and Rotary Compressors: Reciprocating compressors, effect of clearance volume in compressors, volumetric efficiency, single stage and multi stage compressors, effect of inter cooling in multi stage compressors. Centrifugal compressor- Adiabatic efficiency- Diffuser- Axial flow compressors

LO-3: To Understand the fuel supply and the ignition systems. : Gas Turbines: Simple gas turbine plant- closed cycle and open cycle for gas turbines. Efficiency, work ratio and optimum pressure ratio for simple gas turbine cycle. Parameters of performance- regeneration, Inter-cooling and reheating, closed and semi-closed cycle. Jet propulsion and Rockets.

LO-4: Understand the turbo charging, supercharging and new engine technology : Refrigeration& Air Conditioning: Bell Colemen cycle, Vapor compression cycle. Vapor absorption system, Principles of psychrometry – psychometric Chart and terminology, air conditioning systems.

LO-5: To provide basic knowledge on Refrigeration and Air Conditioning.

*Text Books:*

1. Internal Combustion Engine fundamentals by Heywood J B, ISBN0-07-100499-8 Mc. Graw Hill Company.

2. Applied Thermodynamics-II by R. Yadav.

3. A Treatise on Heat Engineering by Vasandhani and Kumar.

*References:*

1. I.C. Enginxes by V. Ganesan.

2. Thermal Engineering, by R.Y. Rajpuyt

3. I.C. Engines, by Mathur and Nehata.

4. Gas Turbines, by Cohen and Rogers.

5. Fluid Flow Machines, by M.S. GovindaRao, Tata McGraw Hill pub co Ltd.

6. Refrigeration and Air-conditioning, byC.P.Arora and Domokundwar.

## NM 2205 : MATERIAL SCIENCE

Periods/week : 4 Sessional. : 30 Exam: 70 Credits: 3

***Course Objectives:***

* To describe the basics of crystal structure and its types

* To gain a thorough knowledge about crystal defects

* To gain a knowledge about electrical and electronic properties of materials

* To gain knowledge of magnetic and optical properties of materials

***Course Outcomes:***

At the end of the course Student would be able

* To use and apply basics of material science in his own branch of engineering.

* The student will be able to justify the materials behaviour and their properties

* To get basic foundation for learning material technology

* Understand the advances in the materials development.

## SYLLABUS

Space lattice and unit cells. Crystal systems. Indices for planes and directions. Structures of common metallic materials. Crystal defects: Point, Line and Surface defects & effects on properties.

Lo-1: To describe basic definition and conception of materials and physical properties of materials. Solid solutions. Intermediate phases. Inter metallic compounds. Gibbs rule. Binary phase diagrams. Lever rule. Invariant reactions. Iron-Iron Carbide phase diagram. Heat treatment of steel. Isothermal transformation curves. Annealing, Normalizing, Hardening, Tempering, Austempering and martempering of steels. Surface hardening of steels. Carburizing, Nitriding, Cyaniding, Flame and Induction hardening methods.

Lo-2: Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF Classification of steels: I.S., AISI - SAE classifications. Use and limitations of plain-carbon steels. Alloy steels. Plain carbon and low alloy steels. Tool steels. Cemented carbides. Stainless steels. Maraging steels. Hadfield steel. Cast irons. Grey, White, Malleable and SG irons. Alloy cast-irons. Non-ferrous metals and alloys. Copper and copper-base alloys. Brasses and the bronzes. Copper nickel and Monel alloys. Properties and applications. Aluminium, its uses. Wrought and cast alloys of aluminium.

LO-3: To give information about phase diagrams. Plastic deformation: Slip, twining critical resolved shear stress. Ductile and Brittle fracture. Mechanism of Creep and Fatigue. High temperature alloys. Metals at low temperature. Effect of low temperature on properties: Low temperature metals. Powder Metallurgy. Basic steps in and typical applications of powder metallurgy.

Composite materials. Classification. Matrices and reinforcements. Fabrication methods. Examples and applications.

LO-4: To provide fundamental knowledge on powder metallurgy and composite materials.

*Text Books:*

1. Materials Science and Engineering, by V.Raghavan.

2. Physical Metallurgy, by S.H.Avner.

*References:*

1. Materials Science & Engg by L.H.VanVleck, Fifth Edition, Addison-Wesley (1985).

2. Structure and Properties of Materials by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1-4, John Wiley (1966).

3. Essentials of Materials Science by A.G.Guy, McGraw-Hill (1976).

4. The Science and Engineering of Materials by D.R.Askeland, Second Edition, Chapman and Hall (1990).

## M 2206 – ELECTRICAL TECHNOLOGY LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***List of Experiments:***

1. Study and Calibration of wattmeter and energy meter.

2. Measurement of armature resistance, field resistance and filament resistance.

3. Verification of KCL and KVL.

4. Superposition theorem.

5. Parameters of a choke coil.

6. OC and SC tests on transformer.

7. Load test on D.C. shunt machine.

8. O.C. test on D.C. separately excited machine.

9. Swinburnes test.

10. 3 phase induction motor (No load and rotor block tests) load tests.

Alternator regulation by Syn. Impedance method.

## NM 2207 AUTOCAD LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***List of Experiments:***

1. Getting Started with AutoCAD Opening and Creating Drawings Exploring the AutoCAD interface Zooming and Panning

2. Basic Drawing & Editing Commands Using the Mouse, Keyboard, and Enter Key to work quickly and efficiently in AutoCAD Lines Circles Rectangles

3.Projects - Creating a Simple Drawing Creating Simple Drawings Using Object Snap

4.Tracking to extrapolate a projected top view Using Modify tools to arrange an office layout

5.Drawing Precision in AutoCAD Polar and Ortho Tracking Entering Coordinates and Angles Object Snaps and Tracking

6.Making Changes in Your Drawing Move Copy Rotate Mirror Scale Using the reference option with the Scale Tool

7.Drawing Templates Using Template Files (.dwt) to Make New Drawing Exploring what Settings and Elements are saved with Templates

8.Organizing Your Drawing with Layers Layer States Properties by Layer Tools

9.Advanced Object Types Polylines Arcs Polygons Ellipses

10.Analyzing Model and Object Properties The Properties Palette Quick Select Similar Measure Geometry Tools

11.Advanced Editing Commands Trim and Extend Fillet and Chamfer Polyline Edit and Spline Offset and Explode Join

12.Inserting Blocks The Insert Block Command Inserting Blocks with Tool Palettes Dynamic Blocks Migrating Blocks and other Elements between Drawings with Design Center

13. Projects - Creating More Complex Objects

## NM 2208 INTELLECTUAL PROPERTY RIGHTS SKILL DEVELOPMENT COURSE

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 2

***Course Objectives:***

* To introduce the students to Intellectual Property Rights (IPR) which is a key component in modern knowledge management processes

* To create consciousness on IPR in students at an early stage of their education so that they develop an appreciation for ethical and rightful use of existing knowledge

* To make them understand how to take ownership of knowledge they may develop as a result of their creative innovations, take ownership and either drive themselves in becoming entrepreneurs or become responsible knowledge users in society

* To expose students some of the recent debates on the societal implications of IPR and its role in national/international trade and socio-economic development.

***Course outcome:***

Learners will be able to

* Identify the types of intellectual property protection available for their research outcome

* conduct patent search and analyze patentability of the invention

* understand the basic structure of Patent document

* understand the registration and prosecution of different IPs

* understand the basics of IP commercialization and techno/commercial/ legal issues in IPR commercialization

## SYLLABUS

Introduction : Concept of property, Intellectual Property (IP) and Intellectual Property Rights (IPR), Importance of IP, Value creation through IP, Advantages of IP protection, Competitive advantage, Promotion of social good, Prevention of duplicates, counterfeit products and IP

LO-I: To Illustrate research problem formulation : Evolution of IP system

Historical view of IP system in India and abroad, Legal basis and rationale behind development of IP system, WTO and TRIPS agreement, Role of WIPO

LO-2: Summarize the approaches of investigation of solutions for a research problem Types of IPR

Major forms of IP in India and globally, Acts enacted in India related to IP

LO-3: Discover the new developments in IPR Patent

Concept, Life of patent, Rights of Patentee, Criteria of patentability- novelty, non-obviousness, and utility, Non-patentable inventions

LO-4: Outline the process of patenting and development Patent filing and prosecution

Prior art search, Process of obtaining a patent in India, Provisional and complete specification, Convention application, Patent Cooperation Treaty (PCT), Patent Infringement and Enforcement

LO-5: Explain patent right and its scope Trademark

Types of trademarks, Trademark and Brand, Trademark Registration, Trademark Infringeme Copyright

Copyrights and related rights, Copyright registration, Copyright infringement, Section 52 of Indian Copyright Act

Industrial Design What is Industrial design, Design registration, Design infringement

Trade Secret

What are Trade Secrets, How trade secrets are maintained in trade and business

LO-6: Make use of Patent information and databases

Other forms of IP Semiconductor Integrated Circuits Layout Design, Geographical Indications, Protection of Plant Varieties & Farmers' right, Traditional knowledge

LO-7: Discover the new developments in IPR

IP commercialization Licensing & Royalty; Technology Transfer; IP assignment, Compulsory License

Emerging areas Patinformatics, IP and bank loan, IP insurance, IP audit, IP valuation, IP management, Use of artificial intelligence in IP enforcement, Open innovation

LO-8: Explain the procedure for granting patent

*Text Books*

1. Ganguli Prabuddha, Gearing up for Patents The Indian Scenario", Universities Press (1998)

2. Ganguli Prahuddha “Intellectual Property Rights-Unleashing the Knowledge Economy”. Tata McGraw Hill (2001)

3. Geographical Indications of Goods Act 1990 Ganguli Piabaddha “Geographical Indications-its evolving contours accessible in http ips.nminsoda/files/2012/05/main book pdf (2009)

*Reference Books*

1. Ganguli Prabuddha and Jahade Siddharth, “Nanotechnology Intellectual Property Rights Research, Design, and Commercialisation”, CRC Press, Taylor and Francis Group, USA (2012)

2. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities [Paperback J,Darrell A. Posey and Graham Dotfield, IDRC Books; annotated edition (June (1996)

3. Netancl Neil Weinstock, Copyright’s Paradox, Oxford University Press (2010)

4. The Indian Patents Act 1970 (as amended in 2005)

5. The Indian Copyright Act 1950 as amended in 2017)

6. Indian Trademarks Act 1999

7. The Indian Industrial Designs Act 2000

8. The Protection of Plant Varieties and Farmers’ Right Act 2001

9. Inventing the Future: An Introduction to Patents for small and medium sized enterprises, WIPO publication No 917 www.wipo.int/ebookshop

10. Looking Good: An Introduction to Industrial Designs for Small and Medium sized Enterprises; WIPO publication No.498 www.wipo.int/ebookshop

## NM 2209 MC ENVIRONMENTAL SCIENCE

(Common for all Branches)

***Course Objectives***

The objectives of the Environmental Science course are to

* Familiarize the fundamental aspects of environment and the environmental management’

* Provide information of some of the important international conventions which will be useful during the future endeavors after graduation.

* Make realize the importance of natural resources management for the sustenance of the life and the society.

* Apprise the impact of pollution getting generated through the anthropogenic activities on the environment

* Provide the concept of Sustainable Development, energy and environmental management

* Impart knowledge on the new generation waste like e-waste and plastic waste.

***Course Outcomes***

After completion of the course the students will have

* Knowledge on the fundamental aspects of environment and the environmental management

* The knowledge on the salient features of the important international conventions

* Understanding of the importance of natural resources management for the sustenance of the life and the society.

* Familiarity on various forms of pollution and its impact on the environment.

* Understand the elements of Sustainable Development, energy and environmental management

* Knowledge on the new generation waste like e-waste and plastic waste.

## SYLLABUS

Introduction: Structure and functions of Ecosystems-Ecosystems and its Dynamics-Value of Biodiversity-impact of loss of biodiversity, Conservation of bio-diversity. Environmental indicators - Global environmental issues and their impact on the ecosystems.

Salient features of International conventions on Environment: Montreal Protocol, Kyoto protocol, Ramsar Convention on Wetlands, Stockholm Convention on Persistent Organic Pollutants, United Nations Framework Convention on Climate Change (UNFCCC),

LO-I: Articulate the interconnected and interdisciplinary nature of environmental studies; Natural Resources Management: Importance of natural resources management-Land as resource, Land degradation, Soil erosion and desertification, Effects of usage of fertilizer, herbicides and pesticide-watershed management.

LO-2: Demonstrate an integrative approach to environmental issues with a focus on sustainability Forest resources: Use and over-exploitation, Mining and dams – their effects on forest ecosystems and the living beings.

Water resources: Exploitation of surface and groundwater, Floods, droughts, Dams:benefits and costs.

Mineral Resources: Impact of mining on the environment and possible environmental management options in mining and processing of the minerals.

Sustainable resource management (land, water, and energy), and resilient design under the changing environment.

LO-3: Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.

Environmental Pollution: Local and Global Issues. Causes, effects and control measures. Engineering aspects of environmental pollution control systems.

Air pollution: impacts of ambient and indoor air pollution on human health. Water pollution: impacts water pollution on human health and loss of fresh water resources. Soil pollution and its impact on environment. Marine pollution and its impact on blue economy. Noise pollution.

Solid waste management: Important elements in solid waste management- Waste to energy concepts. Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act and their amendments. Salient features of Environmental protection Act, 1986.

LO-4: Appreciate that one can apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.

Sustainable Development: Fundamentals of Sustainable Development– Sustainability Strategies and Barriers – Industrialization and sustainable development. Circular economy concepts in waste (solid and fluid) management.

Energy and Environment: Environmental Benefits and challenges, Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Solar Energy: process of photovoltaic energy conversion, solar energy conversion technologies and devices, their principles, working and applications, disposal of solar panel after their usage. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in context of India.

LO-5: Understand and evaluate the global scale of environmental problems Management of plastic waste and E-waste: Sources, generation and characteristics of various e- and plastic wastes generated from various industrial and commercial activities; Waste management practices including onsite handling, storage, collection and transfer. E-waste and plastic waste processing alternatives. E-Waste management rules and Plastic waste management rules, 2016 and their subsequent amendments.

LO-6: communicate clearly and competently matters of environmental concern and understanding to a variety of audiences in appropriate forms and E-waste

*Text Books:*

1. Bharucha,Erach (2004). Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University Grants Commission, New Delhi.

2. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India

3. Masters, G. M., &Ela, W. P. (1991). Introduction to environmental engineering and science. Englewood Cliffs, NJ: Prentice Hall.

4. Enger, E. and Smith, B., Environmental Science: A Study of Interrelationships, Publisher: McGraw-Hill Higher Education; 12th edition, 2010.

*Reference Books:*

1. Sharma, P. D., & Sharma, P. D. (2005). Ecology and environment. Rastogi Publications

2. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

3. Clark R.S. (2001). Marine Pollution, Clanderson Press Oxford (TB)

4. Jadhav, H & Bhosale, V.M. (1995). Environmental Protection and Laws. Himalaya Pub. House, Delhi 284 p.

5. MoEF&CC, Govt. of India, CPCB: E-waste management rules, 2016 and its amendments 2018.

6. MoEF&CC, Govt. of India, CPCB: Plastic waste management rules, 2016.

## B. Tech - III Year- I Semester

## NM 3101 FLUID MECHANICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Course Objectives: This course offers basic knowledge on fluid statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

Course Outcomes: The student will be able to:

* Identify importance of various fluid properties at rest and in transit.
* derive and apply general governing equations for various fluid flows
* Understand the concept of boundary layer theory and flow separation.
* Plot velocity and pressure profiles for any given fluid flow.
* evaluate the performance characteristics of hydraulic turbines and pumps

### SYLLABUS

Properties of fluids- Viscosity- Pressure measurement and Manometers- Hydrostatic forces on surfaces.

Fluid Kinematics & Fluid Dynamics: Stream line- Stream tube- Stream function- Potential function- Classification of flows- Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity and circulation- Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy- Bernoulli's equation and its applications- Vortex motion- Free and forced vortices- Basic solutions of ideal fluid flows- Flow net analysis.

One dimensional Viscous Flow: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes- Laminar and turbulent regimes- Flow potential and flow resistance- Flow through branched pipes, Momentum equation- Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction, flow through porous media- Darcy's equation. Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations. Laminar Boundary Layer: Momentum integral equation- Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness.

Turbulent Boundary Layer: Laminar- Turbulent transition- Momentum equations and Reynold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.

Dimensional Analysis and Modeling Similitude: Fundamental and derived dimensions- Dimensionless groups- Buckingham p-theorem- Rayleigh method- Model testing- Types of similarity- Geometric, Kinematic and Dynamic similarities- Hydraulic diameter.

Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

*Text Book:*

Fluid Mechanics, by A.K.Mohanty, Prentice Hall of India Pvt.Ltd.

*References:*

1. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications.

2. Foundations of Fluid Mechanics, by Yuan, Prentice Hall of India.

3. Fluid Mechanics and its Applications, by S.K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

4. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, S.Chand & Co.

5. Fluid Mechanics by Kothandaraman and Rudramoorthy.

## NM 3102 SHIP DESIGN-I

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Course objectives: introducing basic ship theory, the ship design process, and systems engineering concepts. Hands on development of a computer code for ship hydrostatics analysis. Hands on experiments on ship stability and resistance. Visits and exercises on board ships. Individual ship design project and related workshops.

***Course outcome:***

This course gives an introduction to naval architecture, i.e. the engineering design of ships and other marine technology systems, and basic ship theory such as hydrostatics, stability, resistance and propulsion. The objective is that students after finishing the course shall be able to:

* Demonstrate knowledge and understanding of the scientific basis and proven experience of ship design and insight into current research and development work;

* Demonstrate methodological knowledge and understanding in ship hydrostatics, stability, resistance and propulsion;

* Demonstrate ability to model, simulate, predict and evaluate ships' hydrostatics, stability, resistance, and energy and resource efficiency, even on the basis of limited information;

* Demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* Give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* Discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* Demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work;

* Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts.

### SYLLABUS

General Considerations and Introduction to Ship Design Methods: Marketing, manufacturing and operational considerations in Ship design. Technological, economic and sociological factors and national priorities. Ship

design as a science and as an art. Owner's requirements, shipyard production facilities and operational constraints to be considered in the design process. Introduction to ship design method using basic ship or parent ship types, ship design as an iterative process and stages of ship design. The design spiral, design ship categories such as dead weight carriers, capacity carriers, and linear dimension ships. Displacement and volume estimation. Dead weight-displacement ratio, components of dead weight and displacement, determination of main dimensions and form coefficients, use of computers in ship design process.

Estimation of Weight And Volume Components, Design Of Hull Form And Determination Of Stability And Other Criteria:

Weight and capacity equations and their use in ship design. Use of cubic equation. Calculation of weight and volume components using parent ship data or other compiled data. Calculation of steel, wood, outfit and machinery weights, using formulas. Estimation of dead weight components, design of hull form from first principles. Sectional area curve. Design of load water line, sections, stem and stern profiles, other water lines and development of the lines plan., determination of position of the LCB. Preliminary estimation of power and propeller diameter. Preliminary check for rudder area. Use of series data such as BSRA series and Taylor's series. Calculation of stability, free board, trims capacity and tonnage. Stowage factors. Volume required for cargo fuel fresh water and Ballast.

Determination of Engine Power and Selection of Main and Auxiliary Machinery: Calculation of engine power. Relation between resistance and engine power. Criteria for selection of main propulsion plant. Types of main propulsion plants and fuels-their advantages and disadvantages. Different types of power transmission and shafting systems used in ships. Selection of propeller. Propeller types and number and estimation of main propeller parameters, such as diameter, rpm, number of blades, blade area ratio etc. Determination of location, area and volume of engine room. Estimation of size of engine casing. Estimation of electrical power requirement in the ship and deck area and volume required for installation of generators and main switchboard. Functions of various other auxiliary machinery such as boilers, cargo pumps, fuel and lube oil pumps, separators, cooling systems etc.

Cargo Systems and Cargo Handling Gear: Introduction to various types of cargo systems and cargo handling gear used on board ships such as cranes, derricks, Sampson posts, pumping systems etc. Properties and requirements for carriage of different types of cargo. General cargo carriers, light and heavy bulk cargo carriers and ore carriers. Unitised cargo- pallets, containers, barges, etc. and specialised ships for their carriage. Wheeled cargoes. RO-RO ships and ferries. Liquid cargoes-oil tankers liquefied gas carriers and chemical tankers. Selection of cargo handling gear-arrangements for general, bulk, unitised and liquid cargoes. Piping arrangement for tankers.

Important Design Features of Various Types of Ships and other Considerations: General cargo carriers, container ships, oil tankers, passenger vessels, bulk carriers, fishing trawlers, tugs, dredgers, barges, ferries. Different types of hull forms, propulsion systems, main and auxiliary machinery, cargo handling systems and operational requirements suitable of the above mentioned ships. Other consideration in ship design such as water tight integrity, damage stability, manoeuvring and sea keeping criteria, propulsive efficiency, minimisation of hull vibrations, compartments and super structure design in different types of ships. Trimming calculations in various operating considerations. Ballasting arrangements and estimation of total ballast.

*Reference Books:*


1. Ship Design and Construction by R.Taggart
2. Basic Ship Theory, Vol.1 & 2 by K.J.Rawson and E.C.Tupper
3. Principles of Naval Architecture, Vol. 1,2&3 by Ed.V. Lewis


## NM 3103 SHIP CONSTRUCTION

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objective:***

• To be well versed in how to apply various knowledge of architecture on ship operations.

• To Understand Ship Stability and Statically Stability

***Course Outcome:***

* CO 01: To understand the types of Ships

* CO 02: To understand the Stress and Strain in Ships in Still water and in Sea way

* CO 03: To understand the principle part of Ships

* CO 04: To understand the advantages of welding over riveting

* CO 05: To understand the concept of law of floatation

* CO 06: To understand the center of buoyancy and factors affecting the same

* CO 07: To understand the Transverse Statically stability

* CO 08: To understand the Equilibrium of Ship

* CO 09: To calculate of List while Loading, Discharging and/or shifting weights, Correction of List

* CO 10: To understand how to use of hydrostatic tables and curves as supplied to ships, Displacement/draft-curve and table, Light displacement& Load displacement

## SYLLABUS

Introduction to ship building and materials used: A typical ship construction program. Building berth. Building Dock. Multi-stage construction methods. Equipment used in building berths. Use of Goliath cranes. Floating Docks. Ship types. Shipyard layout. Classification societies, development and application of classification rules, role of statutory bodies. Materials for ship construction. Structural steels, special steels, non- ferrous steels, non-metallic materials, material properties and testing of materials.

Joining methods of materials, non-destructive testing.

Storage and preparation of material and structural elements: Material handling and storage, transport system in steel stockyard, material preparation Devices- cleaning, marking processes. The cutting process, Mechanical cutting, thermal

Cutting, optically and numerically controlled cutting, bending of rolled and built-up sections, Plate bending. Nesting of plates.

Fabrication of sub-assemblies, units and hull erection:

Process of prefabrication, welding in prefabrication and erection stages, sub-assemblies, flat Sections, panels- flat and curved, double bottom sections, side tank units, fore-end and aftend Structures, deck and bulkhead structures. Assembly of hull-units. Erection of hull-units

On building berth/dock.

Ship structural components: Functions and details of ship structural components, framing systems, single and double Bottom construction, shell and deck plating, bulkheads, pillars, girders and hatch-coaming, Machinery casings, super structures and deck- houses. Bow and stern Structures. Bossing and Struts, bilge keels and fenders.

Out Fitting, Welding, Testing And Trials And Launching: Various components of outfitting, consisting of systems, equipment and fittings of hull, Machinery and electrical groups. Hull Preservation methods. Various outfitting methods.

Advanced outfitting. Methods of welding, metallurgy of welding weld defects, distortion and Stresses in welds, testing of welds. Inspection and testing during various stages of ship

Construction. Testing of structures and tanks. Bollard tests and sea trials. Details of launching

Arrangements.

*References:*

1. Merchant Ship Construction by D. A. Taylor

2. Ship Construction by D.J. Eyres

3. Ship Design and Construction by R.Taggart

## NM 3106 Marine Thermal Lab

Periods/week : 3 Ses. : 50 Exam : 50

Examination Practical: 3hrs. Credits: 1.5

List of experiments to be conducted:

1. Determination of flash and fire points of oil samples - using Cleveland's apparatus

2. Determination of flash point of oil samples - using Abel's and Pensky-Martin's apparatus 3. Determination of Kinematic viscosity - using Redwood Viscometer – I & II, Saybolt's viscometer

4. Determination of calorific value of solid and liquid fuels using Bomb Calorimeter.

5. Aniline point test,

6. Calibration of pressure gauge - dead weight tester.

7. Volumetric efficiency of reciprocating air compressor.

8. Valve timing diagrams of IC engines (2 & 4 stroke engines).

9. Study of equipment to supplement theory, Boiler models,& I.C. Engine Components.

10. Experiments covering performance and other tests on Diesel Engines – Single cylinder, and Multi cylinder

11. Experiments covering performance and other tests on Petrol Engines

12. Refrigerating system and ice plant

13. Wind Tunnel

## NM 3107 : NAPA LAB

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives***

* The objectives of the course are to provide training and provide hands on experience to the students on NAPA software for the purpose of hydrostatic calculations and resistance calculations

***Course Outcomes***

* At the end of the course, the student will be in a position to model a ship using the softare

* perform a detailed hydrostatic calculation

## SYLLABUS

NAPA Main window features, Project Settings, Hull Modelling, Hydrostatic Calculations, Design Hydrostatics, Hydrostatics, Resistance, Report writing and explanation

## NM 3108 (SC) : Welding Practice

### LIST OF EXPERIMENTS:

(Practical/hands on)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Lap Joints)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Butt Joints)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(T-joint)

Arc welding of mild steel and stainless steel plates and thermal cycle, cooling rate, macrostructure and Micro structural characterization of welds and Arc welding safety(Flange Joints)

Study Experiments (Theoretical)

Spot welding and Spot Welding safety

TIG welding TIG welding safety.

Plasma welding and Plasma welding safety.

Submerged welding and Submerged welding safety.

## NM 3109 INTERNSHIP- I

## B. Tech -III Year- II Semester

## NM 3201 RESISTANCE & PROPULSION

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objectives:***

Students undergoing this course are expected:

* To understand and analyze the gas turbine engine and its components.

* To realize and analyze the thermodynamics of various component of a gas turbine engine.

***Course Outcomes:***

* Apply the working concept of various types of gas turbine engines in practical applications

* Differentiate between a subsonic and a supersonic inlet and further relate it to aerospace applications.

* Analyze the working concept of various types of compressors.

* Illustrate the operational and designing concepts of gas turbine blades.

* Examine the suitability of the combustion chamber & nozzle for a given gas turbine engine

### SYLLABUS

Introduction to resistance: Concept of resistance, flow of non-viscous and viscous fluids past submerged bodies and surface of ships. Introduction to important components of resistance such as frictional resistance, wave making resistance, eddy making resistance and air & wind resistance. Dimensional analysis, conditions of similarity, corresponding speeds of ship and model, Introduction to towing tank experiments and determination of ship resistance.

Viscous resistance and air & wind resistance: Froude's experiments with planks and plates, Reynold's experiments with pipes. Turbulence stimulation, friction lines, form resistance, boundary layer separation, effect of hull roughness, appendage drag, resistance in shallow water full scale tests and ship model correlation.

Wave resistance, estimation of total resistance and effective horsepower: Kelvin wave pattern, waves generated by ship, wave interference, Froude's method of resistance prediction. Resistance data presentation, estimation of total resistance and effective power, trail and service allowances. Aspects of hull form design. Statistical analysis of resistance data by regression.

Propeller Design and hull propeller interaction: Screw propeller terminology and geometry. Dimensional analysis and conditions of similarity. Propeller in open water. Propeller coefficients, hull- propeller interaction, wake and thrust deduction, hull efficiency, relative rotative efficiency, propulsive coefficient. Cavitation, fully cavitating propellers. Propeller design using methodical series data, design of free running propellers, propellers for tugs and trawlers. Elementary treatment including basic principles of momentum theory, blade element theory, lifting line theory and lifting surface theory of propeller. Design of propellers for a variable wake.

Ship Propulsion devices, prediction of ship's power and strength of propellers: Ship Propulsion devices and their historical development, water jet propulsion, controllable pitch propellers, vertical axis propellers, shrouded propellers, tandem and contra-rotating propellers and paddle-wheels, super conducting electric propulsion. Model propulsion experiments in towing tanks and Cavitation tunnels. Ship trails and service performance analysis, estimation of power based on model experiments and propeller design charts, use of Br- d charts,

Kt- Kq- J diagrams. Propeller blade strength methods of calculation, classification society rules, Propeller materials.

*Reference Books:*

1. Principles of Naval Architecture, Vol. II by Ed.V.Lewis.
2. Resistance and Propulsion of Ships by S.A.Harvald.
3. Marine Propellers and Propulsion by J.C.Carlton.

## NM 3202 STRENGTH OF SHIPS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course objective:***

The course objective is to provide students with the knowledge and application skills to meet the knowledge, understanding, and practical assessment requirements for ship construction and stability as part of the requirements for an officer in charge of the navigational watch.

***Course Outcomes:***

* Determine whether stresses on the ship are within the permitted limits by use of stress data

* Understand the fundamental actions to take in the event of partial loss of intact buoyancy

* Demonstrate knowledge of the fundamental actions to be taken in the event of partial loss of intact buoyancy

* Use tables and diagrams of ship stability and trim data to calculate the ship's initial stability, drafts, and trim for any given disposition of cargo and other weights

* Demonstrate knowledge of principal structural members of a ship and the proper names for various parts

## SYLLABUS

Introduction to functions and analysis of ship structures: Functions of ship structure, the forces acting up on a ship at sea, static forces, dynamic forces. The distortion of ship's structure. Application of theory and experience. Limitations of the theory. Distinction between strength and stiffness of hull girder. Forces and moments acting on ship's structures in regular waves in head seas, and oblique seas. Nature of stresses in ship's hull when ship is floating in still water and on a wave. Modeling of ship's' structures including general remarks on structural strength. Three-dimensional analysis of a ship structures (elementary treatment only). Assumptions and simplification of longitudinal strength calculations. Introduction to the use of probability theory in the assessment of longitudinal strength.

Longitudinal strength of hull girder and ultimate strength: Modeling of ship hull Girder as a beam. Assumed form of wave systems. Conditions of Hogging and Sagging. The buoyancy curve. The weight curve. Distributions of dead weight items. The Load, shearing force and bending moment curves. Characteristics of shear force and bending moment curves. Still water bending moment, wave bending moment and total bending moment. Bending theory applied to ship structures and its limitations. Calculations of hull girder section modulus and hull deflection. Dynamic effects on loads acting on the hull due to ship motions and wave action such as slamming. Thermal effects on hull girder. Stresses in the inclined condition. Application of plastic theory to ship structures, stress-strain diagram, calculation of plastic neutral axis and plastic moment. Ultimate strength of a simply supported beam and a fixed ended beam. Ultimate longitudinal strength of a ship.

Transverse strength of hull girder and ship hull material: Transverse loads on ship's hull such as hydrostatic loads, weights, wave loads, racking, and torsion. Effect of hatches and other openings. Strain energy method, moment distribution method and comparison of the two methods, Influence of bracketed connections. Manufacture of steel. Requirement of ship building quality steels, high strength steels, Aluminum alloys and glass reinforced plastics.

Mechanical properties and chemical composition of structural materials: Testing of steels such as tensile test bend test and impact test. Brittle fracture. Steels for very low temperature applications.

Strength of bulk heads, decks and tank tops, foundations, super structure, deck houses and structural discontinuities and local strength problem: Types of bulkheads and loads on bulkheads. Strength analysis of bulkheads. Types of foundations- loads on foundations and Strength analysis. Generation of loads on superstructure. Factors affecting superstructure efficiency. Effective superstructure. Strength of Aluminum alloy superstructure. Strength analysis of decks and tank tops. Determination of scantlings of superstructure decks on the basis of simple bending theory. Strength of deckhouses, structural discontinuities such as holes in plates, notches in beams and girders, deck openings, ends of superstructure, ends of girders and other structural members. Stress concentration due to various structural discontinuities mentioned above. Applications of three-moment theorem to ship structures. Use of strain energy method for solution of bending moment problems and redundant structural problems.

Theory of thin plates, buckling of structures, composite construction, grillage analysis, calculation of scantlings as per rules: Thin plate theory and solution for different boundary conditions. Application of plain stress theory to ship structural problems. Case of a plate acted upon by a concentrated load; Buckling of plates. Influence of stiffeners (longitudinal and \ or transverse) on the buckling stress of ship's plating. Bending and membrane stresses in plates (application to bulkheads, shell plates etc.) Composite construction- Two materials with same elastic modulus. Two materials of different elastic Modulii. Bending of composite beam. Introduction to Grillage. Analysis of simple Grillage.

Scantling calculations according to the rules of classification societies.

*Reference books:*

1. Ship Construction by D.J.Eyres Merchant Ship Construction by D.A.Taylor
2. Principles of Naval Architecture, Vol. II by Ed.V. Lewis.

## NM 3203 SHIP DESIGN – II

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course objectives:***

Introducing basic ship theory, the ship design process, and systems engineering concepts. Hands on development of a computer code for ship hydrostatics analysis. Hands on experiments on ship stability and resistance. Visits and exercises on board ships. Individual ship design project and related workshops.

***Course outcome:***

This course gives an introduction to naval architecture, i.e. the engineering design of ships and other marine technology systems, and basic ship theory such as hydrostatics, stability, resistance and propulsion. The objective is that students after finishing the course shall be able to:

* Demonstrate knowledge and understanding of the scientific basis and proven experience of ship design and insight into current research and development work;

* Demonstrate methodological knowledge and understanding in ship hydrostatics, stability, resistance and propulsion;

* Demonstrate ability to model, simulate, predict and evaluate ships' hydrostatics, stability, resistance, and energy and resource efficiency, even on the basis of limited information;

* Demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* Give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* Discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* Demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work;

* Demonstrate ability to clearly present and discuss engineering conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts

## SYLLABUS

General Arrangements of Ships: General arrangement of ships. Layout of main and other decks. Water tight subdivision of the ship's hull. Disposition of bulk heads and decks. Allocation of cargo and machinery spaces. Bridge and navigation spaces. Arrangements of tanks for fuel oil, ballast water and other liquids. Engine room layout. Cargo handling arrangement, requirement for ships. Accommodation in ships. Design philosophy of accommodation spaces. Living spaces, commissionery spaces, spaces for dining, recreation and services. Access diagrams. Design of super structure and layout. General arrangement and deck layout of general cargo ship, bulk carrier, oil tanker, container ship, passenger ship, fishing trawler, ferry, tug and dredger.

Hull Fittings, Navigational aids and lifesaving appliances: Closing devices, water tight, weather tight, gas tight and non-water tight floors. Windows and portholes. Bulkhead openings, hull openings, cargo port, bow doors, stern ramps. Man holes and access doors.

Hatch covers-weather deck and between deck. Types of hatch covers-sliding, rolling and pontoon. Operating mechanisms. Arrangements for ensuring water tightness. Lifesaving equipment primary and secondary types and ship requirements. Navigational equipment. Bulwarks railings and awnings, gangway, gangplanks, and gangway adders. Masts and rigging, mast designs.

Auxiliary machinery and other Ship Systems: Ship auxiliaries and equipment. Functions of auxiliary machinery and design requirements for location and installation. Selection of components and space allocation for ship systems including electrical system, Fuel and lubricating oil systems. Fresh water and sea water systems, Air conditioning, ventilation, and refrigeration systems, anchoring and mooring gear,

Steering gear types and location, automation of ship systems and ship operation. Unmanned machinery spaces.

International and National regulatory Bodies: Safety and habitability. Impact of the regulatory bodies in ship design, IMO and classification societies, SOLAS, ILLC, ITTC, MMD. Prevention of marine pollution-MARPOL regulations. Free board assignment. Stability in various operating conditions, important features of maritime law of India -regulations regarding a/c, ventilation, noise, vibrations. Survival after damage. Carriage of dangerous goods. Collision prevention.

Ship design organisation and design consideration for special ships and use of computers: Evolution of design philosophy. Changes effected over the years. The "Titatanic Disaster" and impact.

Design features of special types of ships- ice breakers, refrigerated cargo carriers, liquefied gas carriers, aircraft carriers, Ro-RO vessels, SWATH vessels, luxury passenger ships and high speed ships.

Double hull structures for tankers. Hatch coverless containers. Offshore supply vessels, deep sea fishing vessels, use of computers in design of general arrangement and systems. Trends of future developments. Aesthetic considerations in ship design.

*Reference Books:*

1. Ship Design and Construction by R.Taggart

## NM 3206 MARINE HYDRODYNAMICS LAB

Periods/week :3 Ses. : 50 Exam : 50

Examination Practical: 3hrs. Credits: 1.5

Experiments covering the following aspects:

* Pressure, Velocity and flow rate measurements,
* Calibration of Venturimeter.
* Reynolds number of steady pipe flow.
* Calibration of small orifices and mouth pieces.
* Calibration of orifice meters and flow nozzles.
* Vortex motion on the aft portion of blunt bodies.
* Pressure distribution around aerofoil sections.
* Determination of metacentric height of a floating model.
* Visits to Model testing tank to do ship model testing and understand basic facilities.

NM 3207 MARINE INSTRUMENTATION AND METROLOGY LAB

Periods/week: 3 Ses. : 50 Exam: 50

Examination Practical: 3hrs Credits: 1.5

Metrology experiments

* Calibration of mechanical comparator
* Calibration of Micrometer
* Testing of Concentricity trueness and parallelism of a mandrel
* Measurements of taper bar using Dial gauge, bevel protractor and sine bar.
* Distance between two holes of a template using Vernier height gauge.
* Measuring the central height of a circular spigot
* Measuring the pitch diameter, diametral pitch and pressure angle of an involute spur gear
* Study of flatness of slip gauges using optical flats and monochromatic light.
* Calibration of Vernier calipers.
* Calibration of Vernier Height gauge

Instrumentation experiments

* Calibration of thermocouple, thermisiters.
* Calibration of force and stresses using strain gauges.
* Flow rate measurement and roto meter.
* Calibration of pressure gauge.

## NM 3208 SHIP DRAWING – III

Periods/week : 3 Ses : 50 Exam : 50

Examination Theory: 3hrs. Credits: 1.5

Theory (Stability and trim) Transverse and longitudinal stability and trim calculations, effects of movement of liquids, cargo, fuel, fresh water, grain, rules for stability. Calculations and plotting of cross curves, G-Z curves. Stability booklet for ships, DWT scale, cargo loading and unloading, Ballasting and de-ballasting. Inclining equipment, Calculation and estimation of GM in different service conditions. Weight calculations. Introduction and importance of weight calculations in ship design and construction. Calculation of weights of plates and sections, weight calculation data. Detailed estimation of steel weight of ship's hull. Calculation of LCG and VCG of ship and off centre line moments of ship. Calculation of total weight of the ship based on group weights. Calculation of centroid of sections and plates and other structural elements.

Practical: Drawing of Stability Curves, Analysis of inclining experiment and weight calculations, LCG and VCG calculation

## NM 3209 (SC) Soft Skills

***Course Objectives:***

1. To develop skills to communicate clearly.
2. To aid students in building interpersonal skills.
3. To enhance team building and time management skills.
4. To inculcate active listening and responding skills.

***Course Outcomes:***

1. Make use of techniques for self-awareness and self-development.
2. Apply the conceptual understanding of communication into everyday practice.
3. Understand the importance of teamwork and group discussions skills.
4. Develop time management and stress management.

## SYLLABUS

Introduction to Soft Skills: Communication – Verbal and Non Verbal Communication - Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, Just a Minute (JAM) sessions, Adaptability.

Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

*Reference Books:*

1. Krannich, Caryl, and Krannich, Ronald L. Nail the Resume! Great Tips for Creating Dynamite Resumes. United States, Impact Publications, 2005.

2. Hasson, Gill. Brilliant Communication Skills. Great Britain: Pearson Education, 2012

3. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Education, 2001.

4. Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.

5. Rizvi, Ashraf M. Effective Technical Communication: India, McGraw-Hill Education. 2010

6. Thorpe, Edgar &Showick Thorpe. Winning at Interviews. 2nd Edition. Delhi: Dorling Kindersley, 2006.

## B. Tech -IV Year- I Semester

## NM 4107 (SC) Advanced NAPA Practice

Lab Periods/week : 3 Sessional. : 50 Exam: 50 Credits: 1.5

***Course Objectives***

* The objectives of the course are to provide training and provide hands on experience to the students on NAPA software for the purpose of hydrostatic calculations and resistance calculations

***Course Outcomes***

* At the end of the course, the student will be in a position to model a ship using the softare

* perform a detailed hydrostatic calculation

* Obtain the ship resistance

## SYLLABUS

NAPA Main window features, Project Settings, Hull Modelling, Hydrostatic Calculations, Design Hydrostatics, Hydrostatics, Resistance, Report writing and explanation

## B. Tech -IV Year- II Semester

## PROFESSIONAL ELECTIVES

## INTRODUCTION TO OFFSHORE STRUCTURES

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objectives:***

This subject introduces students to basic naval architectural knowledge e.g. naval architectural terms, ship components and simple hydrostatics calculations. It also enables students to familiarize themselves with various offshore engineering sectors including basic knowledge on types of offshore structures and their functions

***Course outcomes:***

On successful completion of this unit, students should be able to:

* Appreciate the shipbuilding industry

* Acquire the naval architectural principles and concepts

* Use the methods of numerical integration and quadrature

* Describe in detail a number of different offshore facility concepts, including the advantages and

* Disadvantages of each understand the various types of fixed and floating offshore platforms, including key design, fabrication

* And installation issues, as well as areas of applicability describe in detail a number of ships from recreational to naval, small to big, operating on or under the

* Sea acquire the basic knowledge of mooring systems and subsea technology

## SYLLABUS

Fundamentals of physical oceanography, drilling technology, mooring systems, study of Environmental forces i.e. waves, wind, tides and current. Types of drilling rig suitability for particular applications. Drill ship- special equipment and operation of drilling rigs- supply crafts, structural arrangements,

and semi-submersibles. Various types of offshore structures- jacket platforms, gravity platforms, complaint structures- guyed tower, tension leg platform etc. Structural systems used. Load calculation- wave, wind, current and functional loads, Soil structure interaction. Analysis of offshore structural components matrix methods-plane frame, grid and space frames. Introduction to dynamic analysis, transportation, launching and upending problems, preliminary design aspects of offshore structures. Safety and reliability of offshore structures.

***Reference books:***

1. Hydrodynamics of Offshore Structures by S.K.Chakravarthy

2. Offshore Structural Engineering by Thomas H.Dawson

3. Mechanics of Wave Forces on Offshore Structures by Turgut Sarpkaya & M. Isaacson.

## II. OCEAN STRUCTURES AND MATERIALS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objectives:***

This subject introduces students to ocean structure knowledge e.g. naval architectural terms, ship components and simple hydrostatics calculations. It also enables students to familiarize themselves with various offshore engineering sectors including basic knowledge on types of offshore structures and materials

***Course outcomes:***

On successful completion of this unit, students should be able to:

* Appreciate the knowledge on Oil and gas resources

* Acquire the Metal principles and concepts

* Use the methods of design and construction

* Describe in detail a number of different Materials facility concepts,

### SYLLABUS

Brief introduction of ocean, Oil and gas resources. Near shore structures. Different types of ocean structures and systems (fixed, floating, semi-submersibles, submersibles, TLP s pipelines, intakes) for exploitation of oil and gas, minerals and energy.

Different materials for marine applications: Behavior of Metals, concrete and other Composite materials for marine environment. Principles of corrosion, properties and selection of materials, Non-destructive testing of materials and structures. Ocean pollution and its effect on ocean structures. Dredging and dredgers.

Brief outline of planning, design and construction. Regulation and codes of practices The environment and environmental forces. Structural analysis and principles of design Foundation and sea bed anchors. Towing, launching and installation.

*References :*

1. Ben C.Gerwick, Jr., Construction of Marine and Offshore Structures, CRC Press, New York, 2000

2. Reddy, D.V.and Arockiasamy, M., Editors, Offshore Structures, Vol.I and II, Krieger Publishing Company, Florida, 1991

3. Per Bruun, Port Engineering, Volume I and II, Gulf Publishing Company, 1989

## III. FINITE ELEMENT ANALYSIS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course Objective:***

* To introduce the concepts of Mathematical Modeling of Engineering Problems.

* To appreciate the use of FEM to a range of Engineering Problems

***Course Outcomes:***

At the end of the course, a student will be able to

* CO1: apply direct stiffness, Rayleigh-Ritz, Galerkin method to solve engineering problems and outline the requirements for convergence.

* CO2: analyze linear 1D problems like bars and trusses; 2D structural problems using CST element and analyse the axi-symmetric problems with triangular elements.

* CO3: write shape functions for 4 and 8 node quadrilateral, 6 node triangle elements and apply numerical integration to solve; 1D and 2D; stiffness integrations.

* CO4: solve linear 2D structural beams and frames problems; 1Dheat conduction and convection heat transfer problems.

* CO5: evaluate the Eigenvalues and Eigenvectors for stepped bar and beam, explain nonlinear geometric and material non linearity

### SYLLABUS

Fundamental Concepts: Introduction, Historical background, Outline of presentation, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-

Ritz method, Hamilton's principle. Galerkin's method, Saint Venant's principle.

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, in plane and Bending, problem modeling and boundary conditions.

Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four-node quadrilateral, Numerical integration, Higher-order elements. Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

*Text Book:*

1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only).

*References:*

1. Introduction to Finite Element Method, by Abel & Desai.
2. Finite Element Method, by O.C. Zienkiewicz.
3. Concepts and Applications of Finite Element Analysis, by Robert D. Cook.
4. Introduction to Finite Element Method, by J.N.Reddy.

## IV. MARINE MANUFACTURING TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. credits: 3

***Course outcome:***

Introduce students to theory and operation of manufacturing including manufacturing processes and equipment overview, manufacturing design, production process and flow, materials, machine operations and logistics.

***Course objective:***

* Identify the different stages of a manufacturing process.
* Interpret the elements of the product design process.
* Identify the common machines used in a manufacturing process.
* Explain the operations and capabilities of machines used in manufacturing.
* Determine the operations used in finishing manufactured products.
* Explain the operations and capabilities of automated machines used in manufacturing.
* Interpret the functionality of base lining and documentation in a manufacturing process.
* Determine the main elements of quality assurance in a process.
* Identify characteristics of end product logistics.

### SYLLABUS

Foundry: Foundry tools and appliances, layout – pattern types, materials, allowances, pattern making, moulding sands, types. Moulding methods, equipment for moulding, casting methods.

Lathe: Working principle, classification, specification, different operations on a lathe, methods of taper turning, cutting speed, feed, depth of cut, machining time and power required for cutting. Turret and capstan lathes.

Shaper and Planer (Elementary Treatment only): Principal parts, classification – quick return mechanisms, table feed mechanism working on shaper and planer, a comparison. Work holding devices.

Drilling and Boring Machines (Elementary Treatment only): Classification, specifications, cutting speed, feed, machining times, parts and description of boring machines, types.

Power Press: Operation, components, classification, selection, cutting dies, power requirements, power press operations, punching, blanking, deep drawing.

Linear and angular measurements: Micrometers, Slip gauges, Vernier and optical bevel Protractors, sine bar Angle gauges.

Comparators: Types, Mechanical, Electrical, Electronic comparators. Measurement of Straightness- flatness- square ness and symmetry-parallelism and circularity.

Metrology: Metrology of screw threads and Metrology of gears (Measurement of Pitch and tooth thickness only).

Grinding: Introduction-abrasives-grinding wheels, bonding processes, selection of grinding wheels-grinding machines-classification-honing-lapping, super-finishing, buffing, polishing, selection of process parameters.

*Text Books:*

1. Engineering Metrology by R.K. Jain
2. Production Technology by R.K. Jain and S.C. Gupta

*References:*

1. Production Technology by P.C. Sharma
2. Workshop Technology, Vol.1, 2&3 by W.A.J. Chapman
3. Machine Tools by Bhattacharya

## V. FISHING VESSELS TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Importance of fishing, Classification of fish for harvesting. Fishing methods- Purse seining, Drift netting, Gillnet fishing, Long line fishing. Pole and line fishing, Trawling, Harpooning.

Fishing Gear- Towed gear, Bottom trawling, side trawling, Towing arrangements, stern trawling operations and equipment, multiring trawling, Midwater trawling, Purse seining Types, Analysis of fishing nets.

Storing and preservation of fish on board a vessel, Fish hold arrangement. Insulation, icing and freezing. Refrigeration machinery.

Design of fishing vessels. Side trawlers, stern trawlers, purse seining. General arrangement, Layout and equipment on deck. Determination of main dimensions. Estimation of component weights. Development of lines. Estimation of resistance. Design of propellers for trawlers. Machinery- main and auxiliary, Electrical systems, structural arrangements. Materials for the construction of fishing vessels.

Economics of fishing vessels. Estimation of initial and operation costs. The influences of size, speed, power, selling price, distance optimised fishing vessel design. Design and economics of simple low cost country fishing crafts.

*References Books:*

1. Design of Small Fishing Vessels by John Fyson
2. Fishing Boats of the World by Jan-Olof Traung

## VI. MARINE HYDRODYNAMICS

Course Objectives: To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

Course Outcomes: Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

### SYLLABUS

Small Amplitude Wave Theory Formulation and Solution: Review of hydrodynamics-Boundary Value Problems, summary of two-dimensional periodic water wave BVP, solution of linearized water wave BVP for a horizontal bottom, dispersion equation, engineering wave properties-water particle, kinematics of progressive waves, pressure field under a standard wave, partial standing waves, energy and energy propagation in progressive waves- principle of conservation of energy. Energy Flux.

Wave Forecasting: Generation of waves-theories of wave generation by Kelvin, Phillips, Milne, Jeffrey, Swerdrup and munk. Concept of fully developed sea, Characteristics of ocean waves, significant wave height and period, wave height variability, energy spectra of waves, simplified wave prediction models-SMB and PNJ. Methods, wave forecasting charts, effects of moving storms and variable wind speed and direction.

Wave Transformation and Wave statistics: Transformation of wave entering shallow water, shoaling of waves in shallow water, wave reflection, refraction and diffraction, combined refraction, diffraction, and wave breaking. Wave Height distribution-single wave train, wave groups, narrow banded spectra, Rayleigh's distribution, wave spectrum, directional wave spectrum-JONSWAP, PNJ and Bretschneider spectra.

Wave Forces: Wave forces on vertical cylindrical bodies due to non-breaking waves – Basic concepts, calculations of forces and moments, Transverse forces due to eddy shedding (Lift forces), selection of hydrodynamic force coefficient, $C_d$ and $C_m$, calculation of forces and moments on groups of vertical and non-vertical cylindrical bodies due to breaking and non-breaking waves.

*Text Book:*

1. Shore Protection Manual, Vols. 1 & 2 by US army coastal engineering research center publication

*Reference Books:*

1. Water Wave Mechanics by Dean and Dlrymple
2. An introduction to Hydrodynamics and Water Waves by B. Le Mehaute
3. Estuary and Coastline Hydrodynamics by A.T. Ippen

## VII. ADVANCED WELDING TECHNOLOGY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Introduction: Classification of welding and related processes. General conditions for welding, edge preparations, and design of welded joints, welding codes and symbols, weldability of metals and metallurgy in welding.

Plastic Welding: Forge Welding: Types, Forged joints etc. Resistance Welding: Principle, types, spot, seam, etc. Thermit welding.

Gas Welding: Principle, equipment, different gas flames, gas welding techniques, types of gas welding, oxy-acetylene, air-acetylene, and oxy-hydrogen welding etc.

Arc Welding: Principle and theory. Arc welding equipment, arc welding current and voltage, polarity of electrodes, angularity of electrodes, precautions in arc welding. Arc welding types, Carbon arc, metal arc, MIG, TIG etc.

Solid State Welding: Principle and types. Latest welding techniques, electron beam, laser beam, metal flame spraying etc. Under water welding (elementary treatment only). Related processes, oxy-acetylene cutting, arc cutting, brazing, soldering etc.

Welding of various Metals: Cast Iron, steel, non-ferrous metals, etc. Welding defects, inspection and testing-design for welding. Safety practices and training in welding and welding machines (elementary treatment).

*Text Books:*

1. Welding Engineering by R.L. Agrawal and Tahil Manghnani
2. A Text book of Welding Technology by O.P. Khanna
3. Welding Technology by N.K. Srinivasan

*References:*

1. Welding Engineering and Technology by R.S. Parmar
2. Welding and Welding Technology by Richard L. Little
3. Welding by A.C. Davies
4. Production Technology by R.K. Jain and S.C. Gupta
5. Elements of Workshop Technology, Vol.1 by S.K. Hajra Choudury
6. Welder Trade Theory by S.K. Singh

## VIII. SEA KEEPING AND MANEUVERABILITY

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory : 3hrs. Credits: 3

***Course outcomes:***

* Apply the concepts of Static Equilibrium and Archimedes' Principle to the operation of a ship.

* Demonstrate the ability to assess the stability condition of a ship. Predict the effect of planned shipboard evolutions on ship stability.

* Understand the significance of damage to a ship which has compromised its watertight integrity. Use hydrostatics to make intelligent and safe choices to maintain a ship afloat and upright.

* Understand the structural arrangement of a ship, including the choice of materials and the stresses developed by loads encountered in its operating environment.

* Understand the different components that make up a ship's resistance and the manner in which the propulsion plant transmits its power to overcome those forces.

* Understand factors affecting the seakeeping and maneuverability of ships in a seaway.

***Course objective:***

This course is an introduction to the applied science of ship systems. The course describes ships and submarines and how they remain afloat from a design and application perspective. Included are topics in hydrostatics, ship stability and operability, materials, fluid dynamics and propulsion.

### SYLLABUS

Introduction to sea keeping: Importance of sea keeping analysis. Behaviour of a ship in a seaway. Regular waves, Sinusoidal and trochoidal Theories.Chacteristics of waves; Sea surface. Analytical and statistical representations. Descriptive characterisation of the sea. Average and significant wave heights. Wave histogram. Characterisation by energy spectrum. Standard sea spectra. Beaufort scale.

Ship motions in regular waves: Surge, sway, heave, roll, pitch and yaw. Coupled and uncoupled motions. Equations of motion, inertial, damping, restoring and exciting forces and moments. Determination of the forces and moments. Tuning factor and Magnification factor. Added mass. Coupled heaving and pitching. Motions in shallow water.

Ship Motions in Irregular waves: Encounter spectrum. Response amplitude operators and their calculation by theory and experiment. Motion spectrum and statistical characteristics of motions in irregular waves.

Dynamic effects: Relative bow motion. Deck wetness and slamming. Added Resistance in waves. Added power. Power increase due to wind and waves. Loss of speed in a seaway. Loads due to motion. Wave loading and bending moments. Vertical and Rolling effects. Sea sickness

Stabilization of ship motions: Roll stabilizers- Bilge keels, Gyroscopic stabilizers, Movement of weight, Rudder action, Jet flaps, Stabilizing fins, Passive and Active tank stabilisers.

Pitch stabilization methods: Ship motion experiments. Generation of Regular and Irregular waves. Captive and free running model tests. Full scale Tests.Design considerations for sea keeping. Seakeeping criteria. ITTC Guidelines. Effect of design parameters and hull form on seakeeping.

Introduction to Manoeuvrability: Controlled and uncontrolled motions. Control Loop. Course keeping. Motion stability of ocean vehicles. Equations of motion. Hydrodynamic derivations. Stability criterion. Course changing. Tuning circle, zigzag and spiral manoeuvers. Heel while turning. Manoeuvering trials.

Control Surfaces: Control surface geometry. Rudders- types and characteristics. Effect of stall, aeration and cavitation.(Flow around rudder,Influence of ship- features on controls fired stability.) Design of rudders. Calculation of steering gear torque. Bending moment and stresses in rudder stock. Structural design of rudders. Other maneuvering devices. Maneuvering in restricted waters. Squat in shallow water. Bank suction effects- Interaction between ships. Theoretical determination of hydrodynamic derivatives of ship and control surfaces. Experimental determination of hydrodynamic derivatives. Estimation of maneuvering characteristics form hydrodynamic derivatives.

*References:*

1.Dynamics of Marine Vehicles by Rameshwar Bhattacharya.

2.Principles of Naval Architecture, Vol. III by Ed.V. Lewis

## IX DYNAMICS OF OFFSHORE STRUCTURE

Periods/week : 4 Ses. : 30 Exam : 70

Examination theory: 3hrs. Credits: 3

### SYLLABUS

Dynamic perspective. Introduction to different types of ocean structures. Development of structural forms for deep and ultra deep waters. Basis of structural design of ocean structures. Environmental forces. Structural dynamics. Basics-SDOF systems Fundamentals of structural dynamics. Mathematical modelling of structural systems. Single Degree of Freedom (SDOF) systems. Characteristics of sing degree of freedom model – formulation of equation of motion. Free and Forced vibration of single degree of freedom systems. Undamped and damped systems.

Structures in the offshore environment - Description of typical offshore structures – Fixed- Compliant Floating - Solid fluid interaction parameters - Spring factor - Added mass and damping Response of offshore structures - Modelling of offshore structures – single and multi-degree freedom systems – effect of foundations

Structural action of ocean structures - Multi-Degree of freedom (MDOF) systems. Formulation of equation of motion - Influence coefficients - Eigen value problems. Dynamic matrix method. Dunkerley's method - Matrix iteration method - Stodla's method.Mode superposition. Mode truncation.Rayleigh-Ritz method.Damping.Rayleigh damping – Caughey damping. Application of dynamics. Fluid structure interaction (FSI).Perforated members. Articulated tower (AT).Freely moving structures - Stability of submerged and floating structures - Stability at small and large angles

Experimental Structural Dynamics. Experimental studies-free floating studies-free decay studies. Experimental investigation on perforated cylinders & perforated TLP model. Structural dynamics, introduction to stochastic dynamics of ocean structures. Motion analysis in random waves - Low frequency oscillation. Dynamic positioning.

Stochastic Dynamics – Introduction to Stochastic Dynamics of ocean structures. Fatigue Prediction. Random Environmental Processes – Response Spectrum.

*References*

1. Wilson, J. F., Dynamics of Offshore Structures, John Wiley, 2002.

2. Clauss, G, Lehmann, E &Ostergaard, C., Offshore structures - Vols 1 & 2, SpringerVerlag, 1992.

3. Chakraborti, S. K., Non Linear methods in Offshore Engineering, Elsevier SciencePubl, .2002.

4. Hooft, J. P., Advanced Dynamics of Marine Vehicles, John Wiley, 1982.

## X. DESIGN OF SMALL CRAFTS

Periods/week : 5 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 4

***Course objectives:***

provides a broad overview of craft design, construction and operation. The craft design process may be broken down broadly into two stages: Conceptual and/or preliminary design. The preliminary design process will normally take the form of a techno-economic appraisal, using a fundamental engineering economy approach.

***Course outcome:***

* demonstrate ability to critically, independently and creatively make the initial design of a ship for a certain transport scenario, taking into account relevant scientific, social, ethical, economic and environmental aspects, and international regulatory frameworks;

* give an account of the international shipping markets and the corresponding stakeholders, goods flow paths, and ship types;

* discuss the opportunities for seaborne transportation in a sustainable society and describe the shipping-related environmental problems and measures for tackling them;

* demonstrate ability to plan and carry out advanced engineering tasks within given frames using appropriate methods and to evaluate this work

## SYLLABUS

Tugs and towing vessels: Types, stability requirements, Bollard pull, powering, Features of tow hook, Equipment. General arrangement, Special features of pusher tugs, Kort-nozzle, Voith-Schneider and Schottel propulsion in tugs. Design aspects.

Dredgers: Types of dredgers, Hydrostatics and stability considerations. Powering and dredging machinery and equipment. Disposal of dredged material. Design considerations.

High speed crafts: Their role in offshore and naval operations. Special features. Design considerations

Fishing vessels: Types of fishing vessels and fishing methods. Special features. Stability requirements and IMCO recommendations. General arrangement. Fishing gear and equipment. Preservation and processing of catch and by-products. Fishing vessel design.

*Text Books:*

1.Principles of Naval Architecture by Ed.V. Lewis

## XI NAVAL VESSELS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

## SYLLABUS

Historical development of different types of naval vessels: Distinguishing features of warship types. Indigenous design and production of naval vessels. Mission requirements and constraints. Concept exploration and development of warship criteria. Determination of main dimensions. Volumes based and weight based criteria. Space allocation and general arrangement.

Design of Hull Form: Warship resistance data, Hydrodynamics of naval vessels. Propellers for warships. Design and construction. Propeller data for heavily loaded propellers. Hydrodynamic design methods. Stability criteria for warships. Damage survival considerations.

Main and auxiliary machinery in warships: Comparative methods of steam, diesel and gas turbine plants. Combined plants. Requirements of sea keeping and stability platform. Stabilisation systems. Special manoeuvring requirements for naval vessels.

Structural arrangements in naval ships: Structural design criteria and design procedures. Shock and methods to reduce its effects. Accommodation. Habitability standards. A/C requirements. Nuclear, bacteriological and chemical defense arrangements. Weapon systems. Guns torpedoes, depth chargers, mines and missiles. Radar and Sonar weapon control systems. Counter Measures.

Detailed study of some modern naval ships: Submarine: General description, pressure hull external structure, diving and surfacing systems. A/C and ventilation systems. Stability, equilibrium polygon. Distance when submerged and while on surface. Propulsion system. Rudder and hydroplanes. Nuclear submarines.

## XII.ADVANCED SHIP THEORY

***Course Objectives:***

* The objectives of the course are

* Teach the student about the various hazards during the life of a marine engineer and the protection that should be provided against those Hazards

* Teach the students how to design a Ship Girder

* Teach the student how to design internal members like panel etc

* Teach the student about the internal and external factors of marine engineers life.

***Course Outcomes***

* At the end of the course the student will

* Be in a position to know about Various Hazards and protection and the environmental pollution aspects of ship's life

* Be capable of performing simple standard calculation for the ship girder,

* Be capable of structural Design of Stiffened plating, panels plating frameworks etc

* Know about the internal and external environmental aspects of the Ship Environment

## SYLLABUS

Hazards and Protection - Flooding and collision Safety of Life at Sea (SOLAS), Abnormal Waves, Environmental Pollution

LO-1: To explain Hazards and protection

The Ship Girder - Standard calculation for the ship girder, materials considerations, Structural Design and Analysis - Stiffened plating, panels plating, frameworks, realistic assessment of structural elements, Fittings

LO-2: To provide Design and Analysis of the ship girder The Ship Environment and Human Factors - The external environment - sea, waves, climate, physical limitations, internal environment, motions, vibration and noise

LO-3: To Explain Human Factors and Ship environment

*Textbook*

Basic Ship Theory by Rawson and Tupper – B&H

*References*

Muckle's Naval Architecture, by Eric Tupper – B&H

Principles of Naval Architecture – SNAME Publications

## XIII. UNDER WATER ACOUSTICS

Periods/week : 4 Ses. : 30 Exam : 70
Examination Theory: 3hrs. Credits: 3

***Introduction Sound***

Wave motion, Sound pressure, Reference intensity, Source level, Radiated power, Limitations to sonar power, Cavitation, Interaction, Changes to arrays, Projector sensitivity, Hydrophone sensitivity, Spectrum level, Sound in air and in sea water,

***Arrays***

Need for projector arrays, Need for hydrophone arrays, Beam patterns, Directivity of a dipole, The general line array, Shading, Shaded arrays: transmit source levels, Directivity index, Line array: beam pattern vs. steer angle, Broadside array: length and spacing, Beam pattern for a continuous line, DI of a simple dipole, DI of a line array, DI of a planar array, DI of a cylindrical array, DI formulae based for simple arrays, Conformal arrays, Spherical arrays, Volumetric arrays, Beam formers, Domes and arrays.

***Propagation of Sound in the Sea***

Propagation loss, Losses, Spreading losses, Absorption losses, Spherical spreading and absorption, Propagation in the real ocean, The speed of sound, Sound speed profiles, Deep sound channel, Reliable acoustic path, Surface duct propagation, Convergence zone propagation, Bottom bounce propagation, Propagation loss models, Ray theory and the Hodgson model, Hodgson example, Performance prediction, Multipath propagation

***Target Strength***

Definition, Formulae, Measurement, Dependence on pulse type and duration, TS of a sphere, TS of some simple shapes, TS of small targets, Mine target strength, Torpedo target strength, Submarine echoes, Beam aspect target strength, Bow aspect target strength, Submarine target strengths, Towed arrays, Target strength reduction, Practical values.

***Noise in Sonar Systems***

Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel, the sonar environment, Self-noise Electrical noise, Machinery noise, Flow noise, Propeller noise, Variation with speed, Variation with frequency, Directivity, Self-noise and radiated noise, Addition of noise levels, Receiver noise factor, Noise factor of a sonar, Acceptable receiver noise level, Alternative calculation, Practical values

***Reverberation***

Sources of reverberation, Scattering and reflection, Boundary roughness, Classes of reverberation, Backscattering strength, Reverberation target strength, Volume reverberation, Boundary reverberation, Scattering layers, Volume scattering strength, Sea surface scattering strength, Bottom scattering strength, Variation with fi-equency, Reverberation under ice.

***The Sonar Equations***

The basic sonar equation, The basic passive equation, The basic active equation, Detection threshold and detection index, Receiver operating characteristics, ROC curves,

***Passive Sonar***

Radiated noise, Radiated noise: source level, Nature of radiated noise, Practical values, Broadband and narrowband, Normalization, A Note on Swaths, Passive arrays, Passive aural, Passive displays, Formulae for detection threshold, Broadband square law detector, Broadband cross-correlator detector, Narrowband processor, Narrowband amplitude detector processor, Passive ranging, Triangulation, Vertical direct passive ranging, Horizontal direct passive ranging, Towed arrays, Bearing ambiguity, Self-noise,

***Active sonar***

Pulse types, Active sonar equations, Reverberation index, Reverberation and Target Echoes in the main lobe, and sidelobes, Range, pings and doppler shift, Reverberation rejection by CW pulses, Practical reverberation envelopes, Fulland half-beam processing, Beam forming, FM phase binning process, CW processing, Large aperture array, Detection performance, Noise and reverberation-limited detection ranges:, Ambiguity diagrams, Very long pulses, Operational degradation factor, Active displays, Unified detection and classification, Bandwidth, Beamwidth, CADAC, Levels of CADAC, CADAC and pulse features, Statistical analysis, Amplitude profiles, Multipath affects classification

*Textbook:*

Sonar for Practicing Engineers – A.D. Waite - Third Edition – John Wiley

References:

1. Principles of Underwater Sound – (1983) Robert J Urick – Mc Graw Hill Publications

2. Understanding Active Noise Control C.H. Hansen

3. Underwater Acoustic Systems Rodney F.W. Coates

4. Underwater acoustics Leon Camp

## XIV. MARINE ENGINEERING -II

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

Engine room arrangements for different power plants – Functions of Auxiliary equipment – Bilge and ballast systems – Other Auxiliaries.

Piping – Piping fittings and valves – Control valves, materials and corrosion in pipes – Colorcodes – Steam traps, Drains and glands.

Pumping systems. General principles - Simple and duplex pumps – Rotary positive displacement pumps — Centrifugal pumps – Axial flow pumps - Bilge , ballast & sanitary

pumps – Boiler feed pumps – air pumps and Ejectors. Centrifugal compressors – Working principles – Impeller and diffuser design.- Performance characteristics – Blade profiles.

Airflow compressors –Working principles – Types – Performance characters – Aerofoil theory – Blade design.

Condensers, Evaporators, Deaerators and purifiers - Auxiliary condensers – Evaporating plant – Distillation plant – Feed heaters deaerators oil purifiers – Self-changing purifiers.

Steering gear- Types of Steam steering gear, Telemotor gear, Hand steering gear, Hydraulic systems, Electro hydraulic steering gear – Electrical steering gear.

*Text Books:*


1. The running and maintenance of marine Machinery - J Cowley.
2. Marine Auxiliary machinery - W.J Fox.
3. Marine Auxiliary machinery and systems - M Khetaguroo
4. Theory and design of steam and gas turbines – Lee


## XV.ADVANCED FLUID MECHANICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objectives:***

This course offers basic knowledge on fluid statics, dynamics and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

***Course Outcomes:***

The student will be able to:

* Identify importance of various fluid properties at rest and in transit.
* derive and apply general governing equations for various fluid flows
* Understand the concept of boundary layer theory and flow separation.
* Plot velocity and pressure profiles for any given fluid flow.
* evaluate the performance characteristics of hydraulic turbines and pumps

### SYLLABUS

Fluid Kinematics & Fluid Dynamics: Stream line- Stream tube- Stream function- Potential function- Classification of flows- Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity and circulation- Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy- Bernoulli's equation and its applications- Vortex motion- Free and forced vortices- Basic solutions of ideal fluid flows- Flow net analysis.

One dimensional Viscous Flow: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes- Laminar and turbulent regimes- Flow potential and flow resistance- Flow through branched pipes, Momentum equation- Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction, flow through porous media- Darcy's equation. Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations. Laminar Boundary Layer: Momentum integral equation- Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness.

Turbulent Boundary Layer: Laminar- Turbulent transition- Momentum equations and Reynold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.

Dimensional Analysis and Modeling Similitude: Fundamental and derived dimensions- Dimensionless groups- Buckingham p-theorem- Rayleigh method- Model testing- Types of similarity- Geometric, Kinematic and Dynamic similarities- Hydraulic diameter.

Compressible Fluid Flow: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

*Text Book:*

Fluid Mechanics, by A.K.Mohanty, Prentice Hall of India Pvt.Ltd.

*References:*

1. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications.

2. Foundations of Fluid Mechanics, by Yuan, Prentice Hall of India.

3. Fluid Mechanics and its Applications, by S.K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

4. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, S.Chand & Co.

5. Fluid Mechanics by Kothandaraman and Rudramoorthy.

## OPEN ELECTIVES:

## I. INDUSTRIAL ELECTRONICS

Periods/week: 4 Ses. : 30 Exam: 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Devices: Semi-conductor diode, Zenor diode - Transistor - Silicon control rectifier.

Rectifiers, Amplifiers, Oscillators, Cathode ray oscilloscope.

Industrial Applications: Poly-phase rectifiers - Control circuits - Motor speed control voltage control, Time delay relay circuits - Photo electric circuits.

Resistance welding, inducting heating - Dielectric heating.

Servomechanism: Open loop and closed loop systems (Elementary treatment only).

Introduction to Digital Electronics: Fundamentals of digital electronics, Number system and codes, Logic gates, Boolean algebra, Arithmetic - logic units, Flip-flops, Registers and counters, Memories: ROM, PROM, EPROM and RAM.

Introduction to Microprocessors: The Intel-8085 microprocessor; Architecture, Instruction set, Execution of instructions, Addressing structures, Timing and machine cycles of 8085 and programming I/O operations, Interrupts, Serial input and serial output, Programming the I/O ports, Programming the timer.

*Text Books:*

1. Industrial Electronics by Mithal (Khanna Publications).

2. Digital Computer Electronics - An Introduction to Micro Computer by Albert Paul Malvino, Tata McGraw-Hill Publishing Co. Ltd., New Delhi-2.

*References:*

1. Engineering Electronics by Ryder-McGraw Hill.

2. Micro Processors by Leventhal.

3. Industrial Electronics by Bhatacharya, Tata Mc-Graw Hill.

4. Industrial Electronics and Control by S.K. Bhatacharya and S. Chatarjee, 1995 Ed., Tata Mc-Graw Hill Pub. Co. Ltd.

## II. NAPA /RHINO /EXACT FLAT LAB

## III. MARINE INSTRUMENTATION AND CONTROL

Periods/week : 4 Ses. : 30 Exam : 70

Examination theory: 3hrs. Credits: 3

### SYLLABUS

Instrumentation: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement. Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

*Text Books:*

1. Automatic Control Systems, by Benjamin C. Kuo.

2. Mechanical Measurements, by R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

*References:*

1. Experimental Methods for Engineers, by J.P.Holman, McGraw-Hill.

## IV SHIP VIBRATION

Periods/Week : 5. Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 4

***Course objective:***

Presentation of the basic notions of the vibration theory and ship vibration. Definition of vibration problems and consideration of possibilities for their solutions. Reliable prediction of vibration level in the ship design stage. Review of vibration measurement procedures and vibration remedy

***Course outcomes:***

Upon completion of the course, students will be able to:

* understand basic principles of ship vibration.

* prepare input data for global hull-girder ship vibration analysis.

* apply analytical and numerical sollutions of free and forced global hull-girder vibration.

* apply FEM to ship vibration problems.

* understand problem of the fatigue of ship structural details and calculation procedures for estimation of the fatigue life

## SYLLABUS

Introduction, Historical Review: The Structure Of Wooden Ships. Transition From Wood To Steel. The Structure Of Riveted Ships And Welded Ships. Riveting And Welding In Ship Building. Structural Changes From Riveted To Welded Ships. General Mid-Ship Section Structural Arrangements For Different Types Of Ships- General Cargo Ship, Oil Tanker-Single And Double Hull, Bulk Carrier, Container Ship, Tug, Trawler, Passenger Ship, Cross Channel Ferry.

Structural Parts And Functions And Classification Rules: Different Structural Elements- Keel, Transverse Frames, Longitudinal Frames, Web Frames, Vertical Keelson, Beams, Girders, Floors, Brackets, Pillars, Stem Bars, Stern Frames, Bulkhead Stiffeners, Platings Etc.-Their Structural Configuration, Design Features And Functional Aspects. Assembly Of Various Structural Elements Into The Structural Parts Of The Ship Such As Double Bottom Structure, Side Shell, Single Bottom Structure, Bulk Head Structure, Deck Structure, Aft-End Structure, Fore-End Structure, Super Structure Etc. Structural Design As Per Classification Society Rules. Use Of Relevant Standards In Structural Design.

Structural Design Of Bottom, Side Shell, Bulkhead, Deck, Fore-End, Aft-End Structures:

Bottom Structures, Structural Design Of Single Bottom And Double Bottom Structures, Their Structural Configuration And Determination Of Dimensions And Scantlings Of Stiffeners, Frames, Longitudinal, Inner And Outer Bottom Plating, Shell Plating And Framing-Layout Of Strakes, Spacing Of Framing, Shell Expansion Plan, Longitudinal And Transverse Frames, Ordinary And Web Frames, End Connections Of Frames, Bulk Heads-Structural Arrangement Of Bulk Heads, Longitudinal And Transverse Bulk Heads, Determination Of Scantlings And Sizes Of Structural Parts Of Bulkheads, Plating And Stiffening Of Bulk Heads, In Flat, Corrugated, Swaged And Non-Water Tight Bulk Heads, Connection Of Bulkheads With Side Shell, Decks Etc., Partial Bulk Heads.

Decks - Deck Plating, Subdivision Of Strakes And Structural Arrangements Of Longitudinal And Transverse Stiffeners. Determination Of Scantling, End-Connections Of Deck Stiffeners. Fore-End Structure-Stem Profiles, Plating And Stiffening Of The Fore End Structures, Panting Arrangement, Stem Design-Built Up Or Cast, Bulbous Bow Construction, Details Of Arrangements, Chain Locker, Hawse Pipes, Paint Stores, Forward Collision Bulkheads, Determination Of Scantlings.

Aft-End Structure-Stern Profiles, Plating And Stiffening Of Aft-End Structure, Stern Frame - Built Up Or Cast, Details Of Stern Tube, Bossings, Shaft Struts Etc. Different Types Of Rudder Configurations And Stern Fittings For These Rudder Types. Nozzles And Propeller Arrangements. Determination Of Structural Scantlings.

Structural Design Of Engine Room, Superstructure, Cargo Handling Arrangements, Hatches, Special Ships, Welded Structures And Computer Applications: Engine Room – Horizontal Subdivision Of Engine Room, Platforms, Decks, Shaft Tunnel And Recesses, Engine Casting, Foundations Of Diesel Engines, Turbines, Boilers, Auxiliary Machinery. Static And Dynamic Loads In Engine Room. Structural Design Of Engine Room And Determination Of Scantlings.

Superstructure – Structural Design And Details Of Openings, Expansion Joints Etc. Determination Of Scantlings, Construction And Design Of Cargo Handling Systems And Equipment – Loads On Derricks, Masts And Rigging. Determination Of Scantlings. Deck Cranes –Details Of Installation And Structural Arrangements Necessary.

Hatch Covers – Loads Acting On Hatch Covers, Various Types Of Hatch Covers And Their Structural Design.Structural Design Of Special Types Of Ships – Fishing Vessels, Tugs, Tankers, Dredgers, Icebreakers, And Submarines.

Stress Concentration And Fatigue In Ship Structures. Computer Applications In Structural Design. Various Methods Of Joining Structural Parts And Elements. Design Of Welded Structures. Problem Of Fracture In Welded Structures. Design And Strength Of Butt – Welds, Fillet Welds, Tee And Corner Joints, Bracketed Connections. Structural Fire Protection.

Hull Vibration Of Ships: Flexural Vibrations Of A Beam. Free And Forced Vibrations, Vibration Of Undammed Spring-Mass System, Damped Vibrations. The Exciting Forces On Hull Of Ships, Modes Of Hull Vibration. Calculation Of Hull Frequencies – Factors Influencing Frequency, Empirical Formulae For Hull Frequency Estimation. Analytical Methods For Calculation Of Hull Modes ( Elementary Treatment Only ). The Stodala's Interpolation Method.

Propeller Exciting Forces. Damping – Types Of Damping. Special Local Vibration Problems – Rudder Vibration, Cavitation, Stress And Vibration Levels, Human Reaction To Vibration.

General Methods Of Reducing Vibrations. Devices For Reducing Main Hull Vibration. Synchronising Devices For Twin – Screw Ships, Rotating Weight Neutralisers, Kurt Nozzles.

*Reference Books:*


1. Strength Of Ship Structures By W. Muckle
2. Ship Construction By D.J. Eyers
3. Principles Of Naval Architecture By Ed.V. Lewis
4. Ship Design And Construction By R.Taggart


## V. CASD (COMPUTER AIDED SHIP DESIGN)

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objective:***

To acquaint and equip with the computer aided design and manufacturing of farm machinery with the help of CAD.

***Course outcomes:***

Successful achievement of master level outcomes is required to receive a passing grade in the course. .

* Ability to create fully constrained solid models that can be quickly modified using standard software tools.

* Ability to use, identify and explain standard features in solid modeling including protrusions, revolutions, cutouts, and patterns

* Ability to use standard software tools to create engineering drawings, or other documents, to fully describe the geometries and dimensions of parts, as well as to document assemblies according to standard practice

* Ability to use standard software tools to create part assemblies and check for clearances.

* Ability to create the drawings of farm implements and their analysis.

* Ability to write the CNC part programming

### SYLLABUS

Fundamentals of CAD - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

Interactive Computer Graphics - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- windowing - clipping - 2D and 3D transformations - Linear transformation- Display files for 3D data - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

Introduction to Finite Element Analysis - CAD techniques to finite element data preparation- Automatic mesh generation- presentation of results - 3-dimensional shape description and mesh generation- CAD applications of FEM.

Database systems, structures, entity-relation models, Application to ship design, model manufacturing and testing, CAD applications in ship building, Computer aided manufacture, Numerical control, Part programming.

*Text Books:*


1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover & E.W.Zimmer.
2. Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.


*References:*


1. Computer Aided Design in Mechanical Engineering, by V.Rama Murthy.
2. Elements of Computer Aided Design & Manufacturing, by Y.C.Pao.
3. Computer Aided Kinetics for Machine Design, by D.L.Ryan.
4. Computer Aided Design and Manufacturing, by C.B.Besant & C.W.K.Lui.
5. Computer-Aided Analysis & Design by S. Ghosal, Prentice Hall of India.
6. CAD/CAM/CIM by Radhakrishna, New age international.

## VI. UNDER WATER ACOUSTICS

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Introduction Sound***

Wave motion, Sound pressure, Reference intensity, Source level, Radiated power, Limitations to sonar power, Cavitation, Interaction, Changes to arrays, Projector sensitivity, Hydrophone sensitivity, Spectrum level, Sound in air and in sea water,

***Arrays***

Need for projector arrays, Need for hydrophone arrays, Beam patterns, Directivity of a dipole, The general line array, Shading, Shaded arrays: transmit source levels, Directivity index, Line array: beam pattern vs. steer angle, Broadside array: length and spacing, Beam pattern for a continuous line, DI of a simple dipole, DI of a line array, DI of a planar array, DI of a cylindrical array, DI formulae based for simple arrays, Conformal arrays, Spherical arrays, Volumetric arrays, Beam formers, Domes and arrays.

***Propagation of Sound in the Sea***

Propagation loss, Losses, Spreading losses, Absorption losses, Spherical spreading and absorption, Propagation in the real ocean, The speed of sound, Sound speed profiles, Deep sound channel, Reliable acoustic path, Surface duct propagation, Convergence zone propagation, Bottom bounce propagation, Propagation loss models, Ray theory and the Hodgson model, Hodgson example, Performance prediction, Multipath propagation

***Target Strength***

Definition, Formulae, Measurement, Dependence on pulse type and duration, TS of a sphere, TS of some simple shapes, TS of small targets, Mine target strength, Torpedo target strength, Submarine echoes, Beam aspect target strength, Bow aspect target strength, Submarine target strengths, Towed arrays, Target strength reduction, Practical values.

***Noise in Sonar Systems***

Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel, the sonar environment, Self-noise Electrical noise, Machinery noise, Flow noise, Propeller noise, Variation with speed, Variation with frequency, Directivity, Self-noise and radiated noise, Addition of noise levels, Receiver noise factor, Noise factor of a sonar, Acceptable receiver noise level, Alternative calculation, Practical values

***Reverberation***

Sources of reverberation, Scattering and reflection, Boundary roughness, Classes of reverberation, Backscattering strength, Reverberation target strength, Volume reverberation, Boundary reverberation, Scattering layers, Volume scattering strength, Sea surface scattering strength, Bottom scattering strength, Variation with fi-equency, Reverberation under ice.

***The Sonar Equations***

The basic sonar equation, The basic passive equation, The basic active equation, Detection threshold and detection index, Receiver operating characteristics, ROC curves,

***Passive Sonar***

Radiated noise, Radiated noise: source level, Nature of radiated noise, Practical values, Broadband and narrowband, Normalization, A Note on Swaths, Passive arrays, Passive aural, Passive displays, Formulae for detection threshold, Broadband square law detector, Broadband cross-correlator detector, Narrowband processor, Narrowband amplitude detector processor, Passive ranging, Triangulation, Vertical direct passive ranging, Horizontal direct passive ranging, Towed arrays, Bearing ambiguity, Self-noise,

***Active sonar***

Pulse types, Active sonar equations, Reverberation index, Reverberation and Target Echoes in the main lobe, and sidelobes, Range, pings and doppler shift, Reverberation rejection by CW pulses, Practical reverberation envelopes, Fulland half-beam processing, Beam forming, FM phase binning process, CW processing, Large aperture array, Detection performance, Noise and reverberation-limited detection ranges:, Ambiguity diagrams, Very long pulses, Operational degradation factor, Active displays, Unified detection and classification, Bandwidth, Beamwidth, CADAC, Levels of CADAC, CADAC and pulse features, Statistical analysis, Amplitude profiles, Multipath affects classification

*Textbook:*

Sonar for Practicing Engineers – A.D. Waite - Third Edition – John Wiley

References:

1. Principles of Underwater Sound – (1983) Robert J Urick – Mc Graw Hill Publications

2. Understanding Active Noise Control C.H. Hansen

3. Underwater Acoustic Systems Rodney F.W. Coates

4. Underwater acoustics Leon Camp

## VII. SHIP CONSTRUCTION

Periods/week : 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objective:***

• To be well versed in how to apply various knowledge of architecture on ship operations.

• To Understand Ship Stability and Statically Stability

***Course Outcome:***

* CO 01: To understand the types of Ships

* CO 02: To understand the Stress and Strain in Ships in Still water and in Sea way

* CO 03: To understand the principle part of Ships

* CO 04: To understand the advantages of welding over riveting

* CO 05: To understand the concept of law of floatation

* CO 06: To understand the center of buoyancy and factors affecting the same

* CO 07: To understand the Transverse Statically stability

* CO 08: To understand the Equilibrium of Ship

* CO 09: To calculate of List while Loading, Discharging and/or shifting weights, Correction of List

* CO 10: To understand how to use of hydrostatic tables and curves as supplied to ships, Displacement/draft-curve and table, Light displacement& Load displacement

### SYLLABUS

Introduction to ship building and materials used: A typical ship construction program. Building berth. Building Dock. Multi-stage construction methods. Equipment used in building berths. Use of Goliath cranes. Floating Docks. Ship types. Shipyard layout. Classification societies, development and application of classification rules, role of statutory bodies. Materials for ship construction. Structural steels, special steels, non- ferrous steels, non-metallic materials, material properties and testing of materials. Joining methods of materials, non-destructive testing.

Storage and preparation of material and structural elements: Material handling and storage, transport system in steel stockyard, material preparation Devices- cleaning, marking processes. The cutting process, Mechanical cutting, thermal Cutting, optically and numerically controlled cutting, bending of rolled and built-up sections, Plate bending. Nesting of plates.

Fabrication of sub-assemblies, units and hull erection: Process of prefabrication, welding in prefabrication and erection stages, sub-assemblies, flat Sections, panels- flat and curved, double bottom sections, side tank units, fore-end and aftend Structures, deck and bulkhead structures. Assembly of hull-units. Erection of hull-units On building berth/dock.

Ship structural components: Functions and details of ship structural components, framing systems, single and double Bottom construction, shell and deck plating, bulkheads, pillars, girders and hatch-coaming,

Machinery casings, super structures and deck- houses. Bow and stern Structures. Bossing and Struts, bilge keels and fenders. Out Fitting, Welding, Testing And Trials And Launching: Various components of outfitting, consisting of systems, equipment and fittings of hull, Machinery and electrical groups. Hull Preservation methods. Various outfitting methods.

Advanced outfitting. Methods of welding, metallurgy of welding weld defects, distortion and Stresses in welds, testing of welds. Inspection and testing during various stages of ship Construction. Testing of structures and tanks. Bollard tests and sea trials. Details of launching Arrangements.

*References:*


1. Merchant Ship Construction by D. A. Taylor
2. Ship Construction by D.J. Eyres
3. Ship Design and Construction by R.Taggart


## VIII.EXPERIMETAL HYDRODYNAMICS

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

***Course Objectives:***

To provide students with a sufficient introduction to each of the topics of the course so that he/she will be able to understand the background of current literature in the hydrodynamics of marine vehicles, offshore engineering, and other ocean-related activities.

***Course Outcomes:***

Students with ocean- and marine-related interest will develop the necessary theoretical and experimental background to keep up with existing literature and begin research on contemporary topics.

### SYLLABUS

Small Amplitude Wave Theory Formulation and Solution: Review of hydrodynamics-Boundary Value Problems, summary of two-dimensional periodic water wave BVP, solution of linearized water wave BVP for a horizontal bottom, dispersion equation, engineering wave properties-water particle,

kinematics of progressive waves, pressure field under a standard wave, partial standing waves, energy and energy propagation in progressive waves- principle of conservation of energy. Energy Flux.

Wave Forecasting: Generation of waves-theories of wave generation by Kelvin, Phillips, Milne, Jeffrey, Swerdrup and munk. Concept of fully developed sea, Characteristics of ocean waves, significant wave height and period, wave height variability, energy spectra of waves, simplified wave prediction models-SMB and PNJ. Methods, wave forecasting charts, effects of moving storms and variable wind speed and direction.

Wave Transformation and Wave statistics: Transformation of wave entering shallow water, shoaling of waves in shallow water, wave reflection, refraction and diffraction, combined refraction, diffraction, and wave breaking. Wave Height distribution-single wave train, wave groups, narrow banded spectra, Rayleigh's distribution, wave spectrum, directional wave spectrum-JONSWAP, PNJ and Bretschneider spectra.

Wave Forces: Wave forces on vertical cylindrical bodies due to non-breaking waves – Basic concepts, calculations of forces and moments, Transverse forces due to eddy shedding (Lift forces), selection of hydrodynamic force coefficient, $C_d$ and $C_m$, calculation of forces and moments on groups of vertical and non-vertical cylindrical bodies due to breaking and non-breaking waves.

*Text Book:*

1. Shore Protection Manual, Vols. 1 & 2 by US army coastal engineering research center publication

*Reference Books:*

1. Water Wave Mechanics by Dean and Dlrymple
2. An introduction to Hydrodynamics and Water Waves by B. Le Mehaute
3. Estuary and Coastline Hydrodynamics by A.T. Ippen

## IX.MARINE POWER PLANT ENGINEERING

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Introduction: Classification of Power Plants, Comparison between land based and Marine Power Plants Performance Characteristics of Marine Power Plants, Fuel Consumption under varying conditions, Marine Power Plants layout.

Marine boilers: Marine Boilers of Fire Tube, Composite and water-tube boilers. Feed water treatment. Feed water supply systems and controls.

Marine steam turbines: Construction details, Compounded steam turbines for Marine applications, Operation and maintenance.

Marine gas turbines: Gas Turbine cycles for Marine applications, Recent trends and developments, Free piston engines, Combined Cycle Plants.

Nuclear power plants: Nuclear fission reaction, types of reactors, Fuels, moderators, Coolants, Control and safety rods, radiation hazards and shielding, Radioisotope applications, Radioactive Waste disposal, Nuclear Powered propulsion, Indian reactor developments.

Marine Refrigeration and Air Conditioning: Marine refrigeration systems-operation and maintenance-application in modern passenger ships, bulk carriers and refrigerated vessels. Air conditioning systems on board the ships-temperature and humidity control-comfort conditioning. Cabin and cargo ventilation- piping and ducting-insulating materials

*Text books:*

1) Marine Power Plants — P.Akinov
2) Nuclear Engineering — D.K.Singhal
3) Marine Engineering — R.Harrington
4) Introduction to Marine Engineering — D.A.Taylor

## XI.MARINE ENGINEERING-I

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Marine Diesel Engines – Low speed and medium speed engines – Auxiliary engines – Scavenging and supercharging systems – Starting and reversing gear – Maintenance – Automation – Hazards in engine room.

Marine Nuclear power installation - Principles of operation of Atomic Reactors – Different types of Reactors – Use of Nuclear reactors in sea going vessels - Radiation hazards and safety – Radioactive waste disposal.

Marine Turbines – Steam turbine Classification based on impulse and reaction principles – Flow thro' blade passages and design – Losses and performance – Compounding, velocity triangles – Starting and Maintenance procedures.

Marine gas turbines – Practical cycles and shaft arrangements - Power turbine – Applications.

Marine Refrigeration – Cycles – Compressors, Condensers, Evaporators and thermostatic valves – Space coolers – Maintenance and Auxiliary equipment.

Marine Air-conditioning – cooling, Heating, Humidication process – Types of Air conditioning systems – Ducting controls.

Ventilation – Requirements and provision – Insulation protection of materials and maintenance.

Marine Boilers – Composite and water tube boilers – Waste heat boilers Arrangement of boiler room – Feed water treatment for Marine boilers – feed supply systems and control.

*Text Books:*

1. Marine Power plant Engineering - Akimov.P
2. Marine I.C Engines-A.B Kane
3. Principles and practice of Marine Diesel Engines – D.K Sanyal
4. Refrigeration and air-conditioning- P.L. Ballaney
5. Marine Steam Boilers- Milton J.H.

## XII HYDRO DYNAMICS AND COMPUTATIONAL METHODS

Periods/week: 4 Ses. : 30 Exam : 70

Examination Theory: 3hrs. Credits: 3

### SYLLABUS

Introduction and Basic Numerical Methods: Introduction to CFD, Approximation and interpolation, Numerical integration, Finite difference approximations of derivatives

The Finite Volume Method for Model Problems: 1-D diffusion, Thomas algorithm for tri-diagonal systems, 1-D convection-diffusion, 2-D model problems

Modeling Navier Stokes Equations: Governing equations for fluid mechanics, Staggered grids, Pressure-velocity coupling – the SIMPLE algorithm, Steady flows, Unsteady flows, Implementation of boundary conditions Commercial CFD codes, Reynolds averaged Navier-Stokes (RANS) equations and turbulence modeling

*Text Books:*

1. Introduction to CFD the finite volume method by Malalasekera & Versfeeg
2. Computational FM and heat transfer by Anderson, Tennehill and Pletchen

## HSS ELECTIVES

## ORGANIZATIONAL BEHAVIOUR

***Course Objectives:***

1. To understand the basic concepts of organisational behaviour, its foundations and importance.
2. To enable students to have a basic perspective of Motivation and Motivation theories.
3. To acquaint the students about group behaviour in organizations, including communication, leadership conflicts and organizational change and how these are linked to and impact organizational performance.

***Course Outcomes:***

1. Indentifying fundamental aspects of organizational dynamics.
2. Evaluate main theories of motivation and formulating suitable motivational strategies.
3. Analyze the behaviour of individuals and groups in organizations.
4. Understanding of Leadership theories and Leadership behaviour.
5. Apply relevant theories, concepts to address important Organizational Behaviour questions.

### Syllabus

Organisational Behaviour : Concept of Organisation - Concept of Organisational Behaviour - Nature of Organisational Behaviour - Role of Organisational behaviour - Disciplines contributing to Organisational Behaviour.

Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation : Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and Mc Gregor's Theory X and Theory Y.

Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication : Downward, Upward and Horizontal communication.

Organisational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Interorganisational conflict - Conflict management.

Organisational Change: Nature - Factors inOrganisational change - Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

*Text Books.*

1.L.M.Prasad: Organisational Beaviour, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organisational Behaviour, Himalaya Publishing House, New Delhi

*Reference Books.*

1. Stephen Robbins: Organisational Behaviour, Pearsons Education, New Delhi.

## INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

***Course Objectives:***

1. To familiarize the students with the concepts of Management.
2. To relate the concepts of Management with industrial organizations.
3. To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.
4. To set forth a basic framework for understanding Entrepreneurship.

***Course Outcomes:***

On completion of the course, the students will be able to:

1. Understand the roles, skills and functions of management.
2. Distinguish the different types of business organizations.
3. Identify the factors involved in Production Operations Management.
4. Diagnose organizational problems and take suitable decisions.
5. Establish good Human Resource Management practices.
6. Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities.

### Syllabus

Basic Concepts of Management: Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills, Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

*Text Books:*

(1 ) Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.

(2) Vasant Desai , The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth),HImalayan Publishing House, 2018.

*Reference Books:*

(1) Aryasri , A.R., Management Science, McGraw HIll Education (India Private Limited, New Delhi 2014.

(2) Sheela, P. , and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

## OPERATIONS RESEARCH

***Course Objectives:***

* Formulate a real world problem as a mathematical programming model.
* Provide knowledge of optimization techniques and approaches.
* Understand and study inventory problems.
* Know the network models.
* Put on knowledge in solving replacement problems and different queueing models

***Course Outcomes:***

* Learned to translate a real-world problem into a mathematical formulation.
* Formulate and Solve Transportation, Assignment and sequencing problems.
* Resolve inventory problems.
* Able to solve maximum flow and shortest path problems.
* Capable to solve replacement problems and analyze queueing models.

### SYLLABUS

Introduction: Definitions of Operations Research; Phases of Operations Research; Types of Operations Research models; applications, merits and demerits of Operations Research.

Allocation: Linear Programming problem formulation; Basic assumptions; Graphical solution; Simplex method; Artificial variable technique; Two phase method; Big M method; Duality principle; Primal and Dual relation.

Transportation: Formulation; Solution methods; Unbalanced transportation problems - North west corner rule; Least cost entry method; Vogel's approximation method; Optimal solution; degeneracy.

Assignment: Formulation; Variations in Assignment problem; Travelling salesman problem.

Sequencing: Sequencing of - n jobs through two machines; n jobs through three machines; n jobs through m machines; 2 jobs through m machines.

Inventory Control: Introduction; Types of Inventory; Inventory costs; Deterministic models - Economic order quantity (EOQ) and Economic Production Quantity (EPQ) with and without shortages; Quantity discounts; P system; Q system; Inventory control Techniques.

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Replacement: Introduction, Replacement of items that deteriorate with time - Value of money unchanging and changing, Replacement of items that fail completely.

Queueing models: Introduction; Single channel poisson arrivals; Exponential service times; Unrestricted queue with infinite population and finite population models; Multi channel poisson arrivals; Exponential service times with infinite population and restricted queue.

*Text Books:*

1. Hamdy A Taha, "Operations Research- An Introduction" by TAHA , Prentice Hall, 2009.

2. F.S. Hiller, G.J. Liberman,B. Nag and P.Basu "Introduction To Operations Research,

Mc Graw Hill Education(India), 2012.

3. S.D.Sharma, "Operations Research", Kedarnadh Ramnadh & Co.,2017

*Reference Books:*

1. R. Pannerselvam, "Operations Research", PHI..

2. Richard Bronson, Schaum's Series," Operations Research", Mc Graw Hill

3. N.V.S.Raju, "Operations Research- Theory and Practice" BS publications.

4. V.K. Kapoor, "Operations Research" Sultan Chand & Sons