

### MODULE I

**Force analysis of plane motion mechanisms :** Static Force Analysis: Analysis of four bar chain – slider crank chain – static force analysis with friction. Dynamic force analysis: D’Alembert’s principle, inertia forces, dynamic force analysis of four bar chain, slider crank mechanism, shaking forces -8 hrs

**Dynamics of reciprocating engines:** Gear force, equivalent masses, inertia force in the single engine, bearing loads in the single cylinder engine, -4 hrs

### MODULE II

**Flywheels:** Inertia torque-turning moment diagrams for multi cylinder engines, coefficient of fluctuation of speed and energy, fly wheel mass calculation, effect of centrifugal tension on fly wheel. -8 hrs

**Gyroscopes :** Motion of rigid body in 3 Dimension, Euler’s equation of motion, gyro dynamics, gyroscope and gyroscopic couples, gyroscopic stabilization of ships and aeroplanes, gyroscopic effects on automobiles. -8 hrs

### MODULE III

**Balancing:** Static and dynamic balancing, balancing of several masses in a plane, balancing of masses rotating in several planes, conditions for complete balancing of an engine, reciprocating and rotating parts, locomotive balancing- hammer blow, variation of tractive effort, swaying couple, locomotive balancing of opposed piston engines. Multicylinder in-line engines – radial engines and V engines. Balancing machines and their principles of working. -12 hrs

### MODULE IV

**Fundamentals of vibration:** Kinematics of vibratory motion: simple harmonic motion, periodic motion and Fourier analysis.

**Vibrations of single degree of freedom systems:** Natural vibration, equation of motion, natural frequency, equilibrium method, energy method, viscous damping, logarithmic decrement, coulomb damping, forced vibration, harmonic excitation with and without damping, non dimensional expression for amplitude and phase, rotating unbalance, critical speed for shafts, support excited motion, vibration isolation.

**Vibration measuring instruments:** Seismometer, accelerometer, vibration exciters. -15 hrs

### MODULE V

**Free vibration of two degree and multi degree freedom systems:** Solution for free vibration, normal modes, vibration absorber, coupled vibration, general solution, matrix method of formulation, numerical evaluation of natural frequencies and natural mode.

**Approximate numerical methods:** Rayleigh’s method – Dunkerly method.

**Torsional vibration** in multi – rocker systems, geared system. -15 hrs

### Reference:

1. Rattan : Theory of machines, Tata McGraw Hill
2. Hollowenko : Dynamics of machinery, McGraw Hill
3. Singeresu S.Rao : Mechanical Vibrations, Addison wesely
4. Myklestad : Fundamentals of vibration analysis, McGraw Hill
5. Denharto : Mechanical Vibration, McGraw Hill
6. Thomas Beven : Theory of machines – Longmans, Green and Co. Ltd.
7. A.Ghosh & A.Mallik : Theory of machines and mechanisms, Prentice Hall

### MODULE I

**General Considerations governing the design of Boilers:** Types of marine boilers, comparison of smoke tube and water tube boilers; Destructive and Non-destructive tests on plates, rivets, welded seams, classification societies requirements for boilers construction. -5 hrs

**Smoke Tube Boilers:** Various types in marine use, Principal dimensions and staying of flat surface of multi tubular cylindrical Boilers. Vertical Auxiliary Boilers. -5 hrs

**Water Tube Boilers:** General description with sketches of principal types of boilers in marine use. -5 hrs

### MODULE II

**Waste Heat Boilers:** Waste Heat recovery calculation, Lamont exhaust gas boiler. Scotch composite Boiler, Cochran exhaust gas and composite boiler, Spanner marine exhaust gas and Composite boiler. Forced Water Circulation Boiler, Double evaporation Boilers -6 hrs

**Boiler Mountings:** Safety Valves – Improved High Lift, Full lift and Full Bore type : Gauge Glass – Ordinary plate type and remote Indicator; automatic feed regulator, three element High & Low water level alarms, Main Steam Stop Valves, Retractable type Soot Blower etc. -4 hrs

**Accessories :** Superheater, Economizer, Air pre-heater & Steam pre-heater; Circulation and use of Unheated Down comers in highly rated boilers; Superheat temperature control, Attemperators and De-superheaters. -4 hrs

### MODULE III

**Operation, Care & Maintenance:** Pre-commissioning procedures, Hydraulic tests, Steam raising and Operating Procedures, Action in the event of shortage of Water. Blowing down of Boiler, Laying up a boiler; general maintenance, External and Internal tube cleaning. Tube renewals, etc. Maintenance, inspection and survey of boilers. -6 hrs

**Refractory :** Purposes of refractory, types of refractory and reasons for failure. -2 hrs

**Oil burning :** Procedure of Liquid fuel burning in open furnace, Various types of atomizer, Furnace arrangement for oil burning, Boiler Control System i.e. master control, fuel control, air control and viscosity control. -4 hrs

### MODULE IV

**Reciprocating/Steam Engines:** History of multiple expansion marine reciprocating engines & steam turbines. -5 hrs

**Layout of Plant:** General layout of plant & description of a modern geared steam turbine installation including auxiliaries in modern use. -4 hrs

**Selection of Materials :** Materials used in various components like blades, rotors, castings, sealing glands, gears etc. & their justification. -2 hrs

**Constructional Details :** Types of blades, method of fixing, solid built-up & drum rotor for impulse and reaction turbines, castings for HP and LP impulse and reaction turbines, diaphragms, nozzles, glands, carbon glands, labyrinth packing glands, main bearings and thrust bearings. -12 hrs

### MODULE V

**Condensers :** Shapes and types of condensers, constructional details, location & method of securing, working principles, contraction and expansion allowances, leak test. Effect – change of temperature, circulating water quantity, change of main engine power, condenser surface. -5 hrs

**Operation and Maintenance :** Turbine drain system, turbine gland steam, warming through a turbine plant, control of speed and power of propulsion, throttle valve control and nozzle control, emergency controls, emergency operation of turbines, vibration in marine steam turbine, steam turbine losses. Breakdown and fault finding. -13 hrs

**Alignment Checking :** By bridge gauge and poker gauge, allowances for expansion, sliding foot, thrust bearing static and dynamic balancing -3 hrs

### References

- |                            |                                   |
|----------------------------|-----------------------------------|
| 1.J.H.Milton               | : Marine Steam Boilers            |
| 2.SC Mc Birnie and W J Fox | : Marine Steam Engines & Turbines |
| 3.Harrington               | : Marine Engineering              |
| Kandy Series Vol. IV       | : Steam Engines                   |
| Kandy Series Vol. II       | : Marine Boilers                  |

**MODULE I**

Importance of economics in Marine Engineering study, Basic economic concepts and terms. Demand analysis, Supply analysis, Elasticity of demand, elasticity of supply. -8 hrs.

Factors of production, Forms of business organization, Economic system with reference to India. -4 hrs.

**MODULE II**

Production function, Law of return, Economics of scale, Iso-product and Iso-cost, Cost – concepts, Cost-output relationship and cost curves in short period, Long period, Revenue – concept, Determination of price under free market and price control by Govt. Types of market, Factors governing extent of market, Pricing under perfect competition, Monopoly, Monopolistic competition and oligopoly. -11 hrs.

**MODULE III**

Money:- Types, Functions, Standard. Inflation:- types, Causes. Commercial Banks – Functions, Functions of Central Banks. Features of Money and Capital market. National Income concepts. - 7 hrs.

Taxation – Direct and Indirect, Govt. Budgets. Economic development, Growth, features of underdevelopment with reference to India. Globalisation of Indian economics. - 5 hrs.

**MODULE IV**

Difference between Domestic and foreign trade. Basis of International Trade:- Trade-theories. Free-Trade Vs Protection. Balance of payments – components, causes of deficit, steps to correct deficit. Exchange-Rates:- Types, determination, Devaluation of currency. Free-convertibility of currency with reference to Indian Rupee. Functions of I.M.F, World Bank, W.T.O. - 10 hrs.

**MODULE V**

Major Shipping Routes. Ports:- types, Problems, factors for good port. Major ports of Indian and World. Port-pricing. Pollution of water – causes and remedies. Deep-sea fishing, Major sea-fishing zones, Off-shore oil producing Zones. India's overseas Trade and Economic Importance with reference to Economic zones. -7 hrs.

Allocation of market resources in a wealth-maximising manner, Public policy issue in marine transportation, Chartering of ships, Flag of convenience, Policy of Protection and subsidy. -3 hrs.

**Reference:**

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|----------------------------------|---------------------|
| 1. Industrial Economics          | : R. R. Barthwalk   |
| 2. Ship Board Operations         | : H. I. Larvey      |
| 3. Practical Ship Handling       | : Armstrong, Malcom |
| 4. Ship Board Operation Problems | : Cyril Hughes      |
| 5. Economics                     | : Paul A. Samuelson |

### MODULE I

**Performance Characteristics of I.C.Engine:** 4 –stroke and 2-stroke cycles; Deviation from Ideal Condition in actual engines; Limitation in parameters, Timing Diagrams of 2-stroke and 4-stroke engines. Comparative study of slow speed, medium speed and high speed diesel engines – suitability and requirements for various purposes Mean Piston Speed, M.C.R & C.S.R ratings. Practical heat balance diagrams and thermal efficiency. -10 hrs

**General Description of I.C Engines:** Marine Diesel Engine of M.A.N., Sulzer, B & W make etc., -4 hrs

**Constructional Details of I.C.Engines:** Principal Components: Jackets and Liners, Cylinder heads, Pistons, Cross heads, connecting rods, Bed Plates, A-Frames, Welded construction for Bed Plates & Frames. Tie Rods. -6 hrs

### MODULE II

**Scavenging:** Scavenging arrangements in 2-stroke engine; Air charging and exhausting in 4-stroke engines; Various types of Scavenging, their merits and demerits, Scavenge pumps for normally aspirated engines; under piston scavenging, Scavenge manifolds. -6 hrs

**Supercharging Arrangements:** Pulse and constant pressure type; Their relative merits and demerits in highly rated marine propulsion engines. Air movements inside the cylinders. Turbocharger and its details. Two stage, un-cooled, radial turbochargers. -6 hrs

### MODULE III

**Combustion of Fuels in I.C Engines:** Grades of suitable fuels. Preparation of fuels for efficient combustion. Fuel atomization, Ignition quality, Fuel injectors and its details. Ignition delay, after burning. -4 hrs

**Compression pressure ratio and its effect on engines:** Reasons for variation in compression pressure and peak pressure, Design aspects of combustion chamber. Control of NOX, SOX in Exhaust emission. -4 hrs

### MODULE IV

**Cooling of I.C Engines:** Various Cooling media used; their merits and demerits, cooling of Pistons, Cylinder jackets & cylinder heads, Bore cooling, coolant conveying mechanism and systems, Maintenance of coolant and cooling system. -5 hrs

**Safety and Prevention of Mishaps in I.C Engines:** Causes and prevention of crank –case explosions and Scavenger fires. Detection of same and safety fittings provided to prevent damage, Uptake fire, Starting air line explosion. Thermal stresses. -6 hrs

**Special features of I.C engines:** Development of long-stroke Engines, implication of stroke – bore ratio, Development in materials in construction & heat treat of M.E components. -3 hrs

### MODULE V

**Forces and Stresses:** Balancing, Overloading, Different type of vibrations & its effects, A/F vibration. -4 hrs

**Fuel pumps and metering devices:** Jerk and Common Rail Systems; Fuel injection systems, helical groove and spill valve type Fuel Pumps. System for burning heavy oil in slow and medium speed marine engine, V.I.T & Electronics injection system. -6 hrs

Effects of viscosity on liquid fuel combustion, Measuring equipment and its working principle, Necessity of variable fuel injection system, Procedure of application on a modern slow speed long stroke engine, Necessity for adoption of fuel quality setting system, Incorporation of FQSL along with the V.I.T system on the engine. -6 hrs

**References:**

1. Harrington : -Marine Engineering
2. A.Kane: -Marine I.C.Engines
3. John B. Woodward: -Low Speed Marine Diesels
4. C.C.Pounder: -Marine Diesel Engines
5. D.K.Sanyal: -Marine Diesel Engines.

## MODULE I

**Steering gears:** Operation and Constructional details of various types of steering machinery. Telemotor systems, transmitters and receivers Variable Delivery Pumps used in steering gears, axial and radial displacement types. Hunting action of Steering gear. Emergency Steering arrangement. Safe Matic Steering Gear with redundancy concept as per SOLAS. Care and Maintenance of Steering Gear Plants. -8 hrs

**Shafting:** Methods of shaft alignment, constructional details and working of Thrust blocks. Intermediate Shaft bearing and Stern tube bearing. Oil water lubricated Stern Tubes. Sealing Glands. Stresses in Tail End, Intermediate and Thrust Shafts. -6 hrs

## MODULE II

**Dry Docking:** Methods of dry docking of ships. Inspection and routine overhauling of underwater fittings and hull. Measurement of clearances and drops. Removal and fitting of propellers (with and without Key). -6 hrs

**Other Ship board equipments:** Incinerators, Sewage Treatment Plant, Engine room crane, chain blocks, tackles, Anchor chain, its testing and survey requirements. Different types of ship stabilizer, Bow Thrusters, Hull Protection arrangements, Overhauling procedure for various Aux. M/c, Bad weather precaution taken, Maintenance of E.R. Stores etc. Importance of LO/FO testing, Methods of testing etc. Use of oil mist detector. -10 hrs

## MODULE III

**Noise and Vibrations:** Elements of aerodynamics and hydrodynamics sound, Noise Sources on Ships and noise suppression techniques, Noise level measurement. Various modes of vibration in a ship (i.e. free, forced, transverse, axial, torsional – Their sources and effects), Resonance and critical speed, Structure borne, and air borne vibration, Anti vibration mountings of machineries, De-tuners, Dampers with reference to torsional vibrations dampers, use of torsion graphs. -15 hrs

## MODULE IV

**Fuels:** Sources of supply, Study of Primary Fuels, Coal, Petroleum, Natural Gas, Classification of Fuels, Treatment of Fuels for combustion in Marine I.C.E. and Steam Plants. Residual fuels, Emulsified Fuels, Merits and demerits of such fuel in marine engines. -12 hrs

## MODULE V

**Lubrication:** Theories of Lubrication, Types of Lubricants and their Properties Suitability of Lubricants for various uses; solid and fluid lubricants. Additive Oils and their specific use. Terminology used in Lubrication systems. Loading pattern of various bearings in marine use and Lubrication system adopted. Different types of bearings used for marine machineries. L.O. analysis & monitoring Engine through report. -18 hrs

### Reference:

1. Smith D.W. - Marin Auxiliary Machinery, Butter worth Publication, London
2. Khetagurov.M. - Marine Auxiliary Machinery and Systems MIR Publishing House, Moscow.
3. Denharto - Mechanical Vibration, McGraw Hill
4. Kewel Pujra - Vibrations and Noise control
5. 3. I. M. E. - The Running and Maintenance of Marine Machinery

## MRE 506 MARINE ENGG. DRAWING ( 85hrs)

Drawing : Advanced Marine Machinery assembly drawings.

### Part – I (Auxiliary Machine)

Marine machinery components are assorted stop & sluice valves and auxiliary equipment dismantled; to be conceptualized in assembly and laid out as working & functional parts. Sectional views in elevation & plans executed. Part sectional views depiction.

### Part – II (Main machine)

Marine engine components dismantled. Assembled drawings of pistons, thrust blocks, liners, connecting rods, crossheads, injection valves, starting valves, Fuel pumps, Stern tube & Tail shaft, Rudder carrier bearing and all equipment with main machinery. Sectional / Outside and plan views of parts fitted / removed & in functional order.

### Reference:

1. V. Lakshminarayanan & M.L Mathur : Machine Drawing-jain Brothers, N.Delhi.
2. N.D. Bhatt : Machine Drawing
3. K.R. Hert : Engineering Drawing with Problems and Solutions.
4. P.S. Gill : A text book of Machine Drawing, Kaston Publishing house, N.Delhi.



## MODULE I

**Ship Types :** Tankers, Bulk Carriers, Container Ships. LNG, LPG and Chemical Carriers, Lash Ships, Passenger Ships, Dredger, Tugs, etc. – Constructional details and requirements.

-4 hrs

**Offshore Technology :** Drilling Ships and Platforms, Supply/Support Vessels-types and Constructions, Dynamic Positioning, Deep Sea Diving System, Fire Fighting Arrangement, Cable Laying Vessels.

-4 hrs

**Ship Surveys :** Survey, Rules, Functioning of Ship Classification Societies, Surveys during Construction, Periodical Surveys as per statutory regulations, retention/suspension of class of a ship, constructional features and rule guidelines for a merchant vessel as per Marpol regulations, IBC and IGC codes. Statutory Certificates and their validity, Ships registration formalities, Intact Stability Criteria under damaged conditions (constructional point of view in compliance with statutory regulations), Enhanced Survey requirements, HSSC.

-7 hrs

## MODULE II

**Geometry of Ship & Hydrostatic Calculations :** Ships lines, Displacement Calculation, First and Second moment of area, Simpson's rules, application to area and volume, Trapezoidal rule, mean and mid-ordinate rule, Tchebycheff's rule and their applications, Tones per Cm. Immersion, Co-efficient of forms, Wetted surface area, Similar figures, Centre of gravity, effect of addition and removal of masses, Effect of suspended mass.

-22 hrs

## MODULE III

**Transverse Stability of Ships :** Statical stability at small angles of heel, Calculation of B.M. Metacentric height, Inclining experiment, Free surface effect, Stability at large angles of heel, curves of statical stability, dynamical stability, Different Characteristic curves of Dynamic stability. AITC formula.

-10 hrs .

**Resistance & Powering :** Frictional, Residuary & Total resistance, Froude's Law of comparison, Effective power calculations, Ships co-relation Factor (SCF), Admiralty co-efficient, Fuel Co-efficient and Fuel consumption. Effect of viscosity and application of I TTC formula.

-5 hrs

## MODULE IV

**Longitudinal Stability and Trim :** Longitudinal BM, MCT1, change of L.C.B. with change of trim, Change of trim due to adding or deducting weights, change in draft & trim because of filling/flooding several tanks with different densities, alteration of draft due to change in density, Flooding calculations, Floodable length curves, M.O.T. method for determination of floodable lengths, factors of subdivision, Loss of stability due to grounding, Docking stability, Pressure on Chocks.

-18 hrs

## Reference:

1. Muckle - Naval Architecture for Marine engineers.
2. Tupper E. - Introduction to Naval Architecture.
3. Comstock - Principles of Naval Architecture.
4. Lewis - Principles of Naval Architecture.

**(A) BOILER CHEMISTRY LABORATORY ( 24 hrs)**

To determine hardness content of the sample of boiler water in P.P.M. – in terms of  $\text{CaCO}_3$ .

To determine Chloride content of the sample of water in P.P.M. in terms of  $\text{CaCO}_3$ .

To determine Alkalinity due to Phenolphthalein, total Alk. And Caustic Alk. Of the sample of water in P.P.M.

To determine Phosphate Content of the sample of water.

To determine dissolved Oxygen Content of the sample of water.

To determine Sulphate content of the given sample of water.

To determine Ph-Value of the given sample.

**(B) HEAT ENGINES & HEAT TRANSFER LABORATORY (40hrs)**

To determine the absolute Viscosity and Kinematic Viscosity of oils by Red Wood viscometer

To determine the flash point and fire point of a given sample of oil.

To determine the percentage of  $\text{CO}_2$  ,  $\text{CO}$  and  $\text{O}_2$  in the flue gases.

To determine the Calorific value of the fuel with the help of Bomb Calorimeter.

To conduct load test on a two stroke single cylinder Petrol engine

To conduct load test on a two stroke single cylinder Diesel engine.

To conduct load test on a 4 stroke single cylinder Petrol engine.

To conduct load test on a 4 stroke single cylinder Diesel engine.

To conduct load test on a 4 stroke 4 cylinder Petrol engine.

To conduct load test best cooling on a 4 stroke twin cylinder Diesel engine.

To determine the Thermal conductivity of good conductors

To determine the Thermal Conductivity of Insulating materials

Heat transfer Through Fins or extended surface.

Heat transfer through Forced Convection.

Heat transfer through Natural Convection

## **MRE 509 ELECTRONICS LABORATORY ( 36 hrs)**

- To study the charging and discharging action of a capacitor
- To study the half wave and full wave rectification circuit without and with filter circuit
- To study the volt-ampere characteristic of high current semiconductor diode
- To study the volt-ampere characteristic of a diode and Zener diode
- To study the characteristic of Junction Transistor
- To study the volt- ampere characteristic of Field Effect Transistor.
- To study the characteristics of Silicon Controlled Rectifier.
- To study the Transistor Bias stability
- To study the Transistor Feed Back Amplifier
- To study the Integrated Circuit operational Amplifier
- To study the Integrating, Differentiating Clamping and Clipping Circuit
- To study the Logic Training Board
- To study the Speed control of a D.C. motor by Thyristor.