CURRICULUM& SYLLABUS

FOR

MASTER OF TECHNOLOGY (M. TECH)
IN
MARINE ENGINEERING& MANAGEMENT

INDIAN MARITIME UNIVERSITY

(A Central University, Govt. of India)

2017

FIRST SEMESTER CURRICULUM

Code	Theory	Contacts periods Per week			Total	Credit
		L	T	P		
MMT/T/101	Applied Thermodynamics & Turbo-Machinery	3	1	0	4	4
MMT/T/102	Marine Machinery and Plant Design	3	1	0	4	4
MMT/T/103	Materials in Marine Environment, Marine Inspection & Survey	3	1	0	4	4
MMT/T/104	Ship Vibration	3	1	0	4	4
MMT/T/105	Management, Qualitative & Quantitative Analysis and Research Methods	3	1	0	4	4
MMT/T/106	Statistics for Business Managers	3	1	0	4	4
	Practical/ Laboratory -I					
MMT/P/101	Vibration Laboratory	0	0	3	3	3
MMT/P/102	Computational Laboratory for Design and Drawing Engineering, Equipment and Systems	0	0	3	3	3
	Total				30	30

SECOND SEMESTER CURRICULUM

Code	Theory	Contacts periods Per week			Total	Credit
		L	T	P		
MMT/T/201	Design of IC Engines	3	1	0	4	4
MMT/T/202	Instrumentation, Automation & Control Systems	3	1	0	4	4
MMT/T/203	Marine Environment Protection & Energy Management	3	1	0	4	4
MMT/TE/XXX	Elective	3	1	0	4	4
MMT/T/205	Financial Management & Cost Accounting	3	1	0	4	4
MMT/T/206	Management Information System	3	1	0	4	4
	Elective (Any One)					
MMT/TE/201	Cryogenic and LNG Vessels	3	1	0	4	4
MMT/TE/202	Electrical Machines and Power Electronic Systems	3	1	0	4	4
	Practical/ Laboratory -II					
MMT/P/201	Control Systems Laboratory	0	0	3	3	3
MMT/P/202	CFD	0	0	3	3	3
Total					30	30

THIRD SEMESTER CURRICULUM

Code	Theory	Contacts periods Per week			Total	Credit
		L	T	P		
MMT/P/301	Special Seminar under Mentor on Marine Engineering or Sea Experience or Industry Experience					5
MMT/P/302	Project under Mentor based on Sea Experience or Maritime Industry Experience					20
	Total					25

FOURTH SEMESTER CURRICULUM

Code	Theory	Contacts periods Per week			Total	Credit
		L	T	P		
MMT/P/401	Viva- Voce on Dissertation					5
MMT/P/402	Final Project /Dissertation Under Supervisor					20
	Total					25

FIRST SEMESTER

Sub. Code : MMT/T/101	Applied Thermodynamics & Turbo-machinery	Hours :72

Various types of turbines, for power generation and ship propulsion with special emphasis on axial turbo machinery.

Gas Turbine: Various types and working principle. Effect of inter cooling, recuperator and reheat on gas turbine efficiency and specific work. Impact of gas turbine pressure ratio and maximum temperature on optimum efficiency for different gas turbine cycles. Analysis of intercooled/ recuperated gas turbine.

[15 Hours]

Steam Turbines: Various types, effect of free power turbine and its applications in marine field. Main features of steam cycles and main parameters affecting cycle efficiency. Reheating and direct contact and non-contact feed heaters in steam cycles. Basic cycle analysis for combined cycle plants in terms of efficiency, work ratio, ratio of mass flow rate in steam to gas turbine cycle, pinch point temperature. Impact of dual and triple pressure levels on combined cycle efficiency. Velocity triangles in axial compressor and turbines and main geometrical and flow related parameters and main non-dimensional groups for characterizing turbo-machinery.

[15 Hours]

Diesel Engines: Design and operating principles of diesel engines, including four and two stroke, naturally aspirated and turbocharged. Diesel engine environmental pollutants and their mitigation.

[15 Hours]

Application of thermodynamics in air compressors. Application of thermodynamics in IC engine combustion chambers, which includes thermodynamic cycles to identify the main variables affecting spark and compression ignition engine efficiency. Gas exchange and combustion processes in diesel engines. Models to represent various gas dynamic and thermodynamic processes in diesel engines. Analyse the performance of two stroke diesel engines, including large displacement slow speed engines used for marine propulsion and stationary power generation.

[15 Hours]

Method of Power Plant Measures and Criteria, Simple and Advance Steam Plant, Simple and Advance Gas Turbine Plant, Simple and Advance Refrigeration Plant, Nuclear Power Plant, Combined Binary Power Plant, Thermodynamic availability and irreversibility, Boiler circulation Theory.

[12 Hours]

Reference Books:

1. Gas Turbine, Combined Cycle, Turbomachinery- Henry Cohen, G.F.C.Rogers, and Saravanamuttoo, H.I.H.
2. 'Gas Turbine Theory',R.W Haywood
3. 'Analysis of Engineering Cycles – Power, Refrigerating and Gas Liquefaction Plant', Kehlhofer, R., Bachmann, R, Nielsen, H. And Warner, J.,
4. 'Combined Cycle gas turbine Power Plants', Pennwell, 2nd edition.
5. 'More practical aspect of combined cycles', Horlock, J.H.
6. 'Combined Power Plants', Pergamon, 1992. (VA 165)
7. 'Deals with cycle analysis',Stone, R.,
8. 'Introduction to Internal Combustion Engines' Palgrave, 1999, Heywood, J. B.
9. 'Internal Combustion Engine Fundamentals', McGraw-Hill, 1988 or later editions.

FIRST SEMESTER

Sub. Code : MMT/T/102	Marine Machinery and Plant Design	Hours : 72

Machinery:Coupling of a prime mover, Transmission system, gear box, systems and equipments including hydraulic and pneumaticTransmission, type and applications; hydraulic & pneumatic coupling of a prime mover.
Gear design: Load analysis, bending and Hertizian stresses, design procedure and gearbox selection
[12 Hours]

Reliability: Identify and manage cost drivers, concept of risk assessment, subjective and quantitative risk assessment; failure rate estimation of individual components; Application of Reliability, Availability and Maintainability (RAM) based analysis to an engineering system; Design and selection of components in a power train. Factors affecting the performance of hydraulic and pneumatic systems. Use of Mathematical tools for the design and for critical assessment of the major factors affecting the performance of a power train system and its coupling to a prime mover. Different combinations of systems based on analysis of capability, reliability, development, running and life-cycle costs. Mathematical modeling of mechanical, hydraulic (actuators, motors and pumps) and electric systems (passive and active networks, DC/AC motors and actuators).

* The study will cover the modeling in LabVIEW/ Mat lab / Simulink.

[18 Hours]

Life cycle prediction of machinery installations: Introduction, Marine system integration, integration of combustion system, integration of dynamic interactions, life cycle influenced parameters, measured degradation verses life cycle with different parameters i.e wear, heat, corrosion, moisture, fatigue, failure influences on life cycle weight factors. Life cycle influencing parameters e.g. wear, heat, corrosion, moisture, fatigue etc.; Life Cycle Weight Factors; Measured degradation verses life cycle prediction. [15 Hours]

Condition monitoring of diesel engines : Introduction, Advanced monitoring systems, Process models, Component models, Input and output variables, Component models for the charge Air cooler and Condition parameters, Component models for the charge air compressor and Condition parameters. Fault diagnosis.

[15 Hours]

Diesel exhaust control, Reduction of emission of NOx and SOx: Introduction of marine emissions, Incentives for engine makers or Industries, Environment technology industry, Reducing agent for emission, Primary and secondary measures, Reduction of SOx, Reduction of NOx.

[12 Hours]

Reference Books:

1. Marine Systems Identification, Modeling and Control by Roskilly, Tony & Mikalsen, Rikard.
2. Introduction to practical marine engineering. Rowen, A.; Gardner, Raymond; Femenia, Jose; Chapman, David; Wiggins, Edwin.

FIRST SEMESTER

Sub. Code : MMT/T/103	Materials in Marine Environment, Marine Inspection & Survey	Hours :72

Introductions to Materials:
Crystalline structure, Crystal defects and non-crystalline structure, Diffusion, Mechanical behaviour, Thermal behaviour, Failure analysis and prevention, Iron-carbon diagram, Phase diagrams, Heat treatment, Phase transformations, Structural materials – Metals, Electrical and Magnetic properties, Semiconductors, Superconductors. [6 Hours]

Materials:
Solid solutions and alloys; Phase transitions; Overview of crystal structures: Structure, Property relations; Neumann's law; Thermal properties; Optical properties; Electrical properties; Dielectric properties; Magnetic properties & Mechanical properties, Selection of materials for marine construction. [8 Hours]

Steel:
Modern steel for ship building, Mild Steels, High Yield (HY) steels, High Strength Low Alloy (HSLA) Steels, Ultra Low Carbon Bainitic (ULCB) steels;Thermo Mechanically Controlled Processed (TMCP) steels. Other micro alloyed steels, Cooling processes and their effects on mechanical properties; Stress strain characteristics; [8 Hours]

Aluminum and Alloy Materials in Marine Applications:
Properties and attributes of aluminum, Application of Aluminum in marine industry, Main advantages and disadvantages, Types of aluminum alloy commonly used on ships and their production techniques. [6 Hours]

Composite Materials in Marine Applications:
Reasons for use of composite materials onboard ships, testing methods, Structural health monitoring, Life cycle assessment of composite material, Safety challenges and precautions. [6 Hours]

NanoMaterials in Marine & other associated Applications:
Sources of nanoparticles and their health effects, Application of nanomaterials, Main differences between nanomaterials and bulk materials, classification of nanoparticles, Production method of nanomaterials. [6 Hours]

Welded Construction of Ships: Requirements; Weld induced distortions; Distortion mitigation techniques; Welding flaws & reasons for same. [6 Hours]

Material Failure Tests and Evaluations: Metal behavior under different environments; Experimental methods of testing; Rate of atmospheric oxidation and thermal oxidation by marker test; Thermo-gravimetric test; Salt spray test etc; Identification of surface, subsurface; Deep seated discontinuities in metals by suitable non-destructive testing (NDT) techniques; Introduction to fracture mechanics to evaluate the tolerance limit of surface flaws for useful usage. [6 Hours]

Corrosion Principle:
Corrosion Principles; Factors influencing corrosion; Types of corrosion; Electrochemical Aspects; Environmental Effects; Metallurgical effects; Mechanism of corrosion; Galvanic or two metal corrosion; Crevice corrosion; Atmospheric corrosion; Pitting; Inter granular corrosion; Selective leaching; Erosion; Stress corrosion cracking; Hydrogen induced corrosion; Fatigue corrosion; Corrosion due to bio-fouling; Microbial corrosion; Corrosion rate expressions for measurements. [8 Hours]

Corrosion Control and Prevention:
Materials selection; Corrosion due to alteration of environment; Design for cathodic and anodic protection & their Comparison; Protective coating: Metallic coating and other inorganic coating; Coating system selection; Paint system: Protection by means of Paints; Antifouling paints; Corrosion protection system of hull structure. Corrosion control by glass-fiber reinforced polymer (GRP); Bio-fouling control; Corrosion inhibitors; Anodic inhibitor; Marine coating; Corrosion resistant materials for propeller, pump, heat exchanger, hull and wire ropes. [6 Hours]

Standards, Marine Inspection and survey:
National and International Material Standards; Classification Society & Statutory requirements for inspection of materials and survey of marine machinery including marine coatings.[6 Hours]

Reference Books:

1. Robert.E. Newnham, Properties of Materials: Anisotropy, Symmetry, Structure, Oxford University Press.
2. Corrosion and Corrosion control - R. Winston Revie and Herbert H Uhlig; John Wiley & Sons Inc.
3. International Association of Classification Societies harmonized common structural rules.
4. Corrosion Control for Offshore Structures-Cathodic Protection and High Efficiency Coating by *Ramesh Singh.*
5. Composite materials for marine applications-key challenges for the future by R.A. Shenoi, J M Dulieu-Barton, S Quinn, J I R Blake and S W Boyd.
6. Nano-materials and nano-particles: Sources and toxicity by Cristina Buzea, Ivan. I. Pacheco Blandino and Kevin Robbie.

FIRST SEMESTER

Sub Code : MMT/T/104	Ship Vibration	Hours : 72

Vibration:
Undamped Free Vibration: Systems with single degree of freedom, Equilibrium method, The energy method, Rayleigh's method, Stiffness of spring elements. Damped Free Vibrations: Viscous damping, laws of damping, logarithmic decrement. Forced Vibration with Harmonic Excitation: Steady state solution with viscous damping. [12 Hours]

Method of complex algebra, Reciprocating and rotating unbalance, Base excitation, Vibration isolation, Air springs, Energy dissipated by damping, Equivalent viscous damping, Structural damping, Sharpness of resonance, Vibration measuring instruments, Whirling of rotating shafts, Rigid shafts supported by flexible bearings. Two degree of freedom system: Vibration of undamped two degree of freedom system, coordinate coupling, vibration absorber. [12 Hours]

Multi-degree freedom system: Influence coefficients, generalized co-ordinates, matrix method, orthogonality principle, matrix iteration method. Vibration of Beams: Uniformly loaded, Carrying more than one concentrated load, Energy method, Dunkerley's method, Rayleigh's method. Torsional Vibration: Two rotor system, three rotor system, multi-rotor system, Geared system.
[12 Hours]

Vibration of Floating Structures:
Vibration induced in floating elastic structure like ship due to wave, propeller and machinery; The basic concept of structural vibration; Free and forced vibration of single degree of freedom system; Empirical formulae for the evaluation of frequencies in ship hull vibration.

Free and forced vibration of multi-degree of freedom system; Vibration of a continuous system; Concept of added mass and its effect in ship hull vibration; Hull resonance diagram; Selection of engine and propeller based on vibration considerations; Design of engine mounts. Vibration analysis by FEM.
[12 Hours]

Ship Dynamics:
Ocean Waves: Regular waves. Trochoidal waves. Sinusoidal waves. Group velocity. Energy in a wave. Higher order wave theory. Irregular waves. Statistical representation of a seaway.
[12 Hours]

Ship motions in regular and irregular waves. Effects of ship motions – slamming, deck wetness, speed loss, forces on ship structure. Seakeeping model experiments. Motion stabilization. Sea keeping performance.
[12 Hours]

Referencesbooks:

1. Vibration analysis and design of foundations for machines and turbines: Dynamical problems in Civil Engineering- A. Major -Akademiai Kiado Budapest Collets Holding Ltd.
2. Theory of Vibration with Application- W. T. Thompson.
3. Dynamics of Marine Vehicles – Rameswar Bhattacharyya
4. Mechanics of Marine Vehicles- Bishop & Clayton
5. Sea keeping: ship behaviour in rough weather: Lloyd, A. R. J. M.

FIRST SEMESTER

Sub. Code : MMT/T/105	Management, Qualitative & Quantitative Analysis and Research Methods	Hours : 72

Scope of Management:- Management and Leadership, Interpersonal skills, Operations Management, Financial Management Marketing Management, Human Resource Management. Strategic Management; Quality Control; Materials and Maintenance Management. ManagementInformation Systems (MIS). Decision Support System (DSS) Total Quality Management(T.Q.M).

[15 Hours]

Project Management: Definition of Project and Project Management; Project Planning & Control,Stages of a Project: Project Management processes such as Initiation, Planning, Execution, and Closure; Feasibility studies and PERT, CPM, network, models, time-cost trade off concepts, resource allocation and Project monitoring and control; Project Integration Management; Computer applications for better Project Management. Optimization: Schematic View of Optimization process, Optimization Methods in management science, and applications of optimization; Optimization methodologies including linear programming, network optimization, integer programming, and decision trees. Applications to logistics, manufacturing, transportation, marketing, project management, and finance.

[20 Hours]

Quality Management Tools & Quantitative Techniques

Failure Analysis Tools: Fault Tree Analysis, Failure Mode and Effects Analysis, Root Cause Analysis, and Ishikawa Diagram.

Lean and Six Sigma, Theories in the context of marine, or marine related, examples: statistical package MINITAB. Modelling and simulation software: Simulation Modelling, decision analysis, Queuing Systems, Markovian decision Process, TORA PRIMER Software

[20 Hours]

Safety Management: Analysis and Classification of Accidents, Identification of Key Factors, Investigation,Corrective and Preventive Actions.

ISM Code [10 Hours]

Designing Research Problems: Meaning, objectives, significance and motivations in research – Types of Research – Research Approaches – Defining and Selecting a research problem and techniques involved – Features of a Good Design; Important Concepts relating to research Design – Different Research Designs – Basic Principles of Experiment Design

[7 Hours]

Reference Books:

Management

1. Principles of Management - Koontz & O Donnel
2. Fundamentals of Management- Chhabra T.N
3. Essentials of Management: B.P. Singh and A.K. Sing

Project Management

1. A Guide to Project Management- project Management institute
2. Clifford F Gray, Erik W Larson, "Project Management-The Managerial Process" Tata Mcgraw-Hill Publishing Co Ltd.
3. Jack Meredith, Samuel J. Mantel Jr. "Project Management- A Managerial Approach" John Wiley and Sons
4. John M Nicholas "Project Management For Business And Technology" Prentice Hall Of India Pvt Ltd
5. James P Lewis "Project Planning, Scheduling And Control" Tata Mcgraw-Hill Publishing Co Ltd

Quantitative Analysis

1. Operations Research – An Introduction- Hamdy A. Taha
2. Quantitative Methods for Business decisions- Jon Curwin

Quality Management

1. Total Quality Management"- Besterfield, Pearson Education, 2011. ISBN,
2. Quality Control - Dale H Bester field – Pearson Education
3. ISO 9001:2015

Safety Management

1. Techniques of Safety Management: A Systems Approach, Dan Peterson, American Society of Safety Engineers
2. ISM Code

Research Methods

1. Research Methodology (Methods and Techniques) – 3rd Edition – New Age Publishers – C.R. Kothari (2014)

FIRST SEMESTER

Sub. Code : MMT/T/ 106	Statistics for Business Managers	Hours : 72

Introduction to Statistics

Scope and Application of Statistics –Tabulation and Frequency distribution-Presentation of Data – Diagrams, Graphical Presentation Frequency polygon-Measure of Central Tendency: Mean, Median,Mode- Properties of Standard Deviation, Coefficient of Variation – Probability: Discrete and Continuous Probability Distributions - Bayes' Theorem.

[12 Hours]

Sampling and Hypothesis Testing

Sampling theory-Types of sampling-Relationship between Sample Size and Standard Error – Hypothesis Testing: One-sample and Two Sample Tests-Chi-Square and Analysis of Variance-Analysis of Variance - Inferences about a Population Variance - Inferences about Two Population Variances-Solving Problems using Excel.

[15 Hours]

Correlation and Regression Analysis

Causation and Correlation-Types of Correlation- Measures of Correlation-Scatter diagram-Karl Pearson's correlation-Spearman's Rank Correlation Coefficient -Regression analysis: coefficient, Standard Error of Estimate - Multiple Regression Analysis (MRA), Principle Component Analysis (PCA) - Reliability of Estimates - Application of Multiple Regressions-Solving Problems using Excel.

[15 Hours]

Time Series and Forecasting, Index Number

Time Series and Forecasting-Trend Analysis- Cyclical, Seasonal and Irregular Variation – Moving Averages and Exponential Smoothing- Index Numbers-Unweighted Aggregates Index- Weighted Aggregates Index- Average of Relatives Methods- Quantity and Value Indices- Issues in Constructing and Using Index Numbers-Solving Problems using Excel.

[15Hours]

Decision Methods and Basics of Game Theory

Decision Environment- Expected Profit under Uncertainty- Assigning Probability Values- Using Continuous Distributions: Marginal Analysis - Utility as a Decision Criterion - Helping Decision Makers Supply the Right Probabilities - Decision - Tree Analysis –Game Theory; The Formulation of Two-Person, Zero-Sum Games - Solving Simple Games - Games with Mixed Strategies.

[15Hours]

Reference Books:

1. RICHARD I. LEVIN, et. al, (2013), Statistics for Management – 7th Edition – Pearson: New Delhi
2. FREDRICK S. HILLIER et. al., (2012) Introductions to Operations Research –9th Edition – Tata McGraw Hill: New Delhi
3. DAVID R. ANDERSON, DENNIS J. SWEENEY, (2014),Statistics for Business & Economics - Cengage Learning

4. BARRY, R., RALPH, M. S., & MICHAEL, E. H., (2005) Quantitative Analysis for Management. Pearson Education
5. BHARDWAJ, R.S, (2008) Business Statistics. 2nd edition, Excel Books
6. CHARLES, A. G., & HUGH. J. W., (1985) Quantitative Methods for Business Decisions. McGraw Hill
7. HILLIER, S. F., & GERALD, J. L., (2005) Introduction to Operations Research. Tata McGraw-Hill

FIRST SEMESTER

PRACTICAL/LABORATORY

Sub. Code : MMT/P/101	Vibration Laboratory	Hours : 54

1. Mass-Spring Systems
2. Torsional Vibration
3. Forced Vibration with Negligible Damping
4. Two Degrees of Freedom Torsional Vibration
5. Whirling of Shafts
6. Experimental Analysis of:
   (a) Unbalanced rotor
   (b) Bent Shaft
   (c) Faulty bearing
7. Complete analysis of any four or higher bar mechanism

Sub. Code : MMT/P/102	Computational Laboratory for Design and Drawing Engineering, Equipment and Systems	Hours : 54

1. Auto CAD basics and tools operation
2. Simple structures design (2D and 3D)
3. CAM based analysis of 2D and 3D structures
4. Solid Edge Software tools operation
5. Design of 2D & 3D structures by solid edge software
6. Program using MAT LAB tool boxes
7. MAT LAB based formulation &simulation of 2D & 3D structures

SECOND SEMESTER

Sub. Code : MMT/T/201	Design of IC Engines	Hours : 72

Introduction: Modeling of Internal Combustion Engines; Computational Optimization of Internal Combustion Engines, Engine Optimization with Parametric Studies;Engine geometry Brake Performance, Indicated Performance, Friction Relationships among performance parameters.

[10 Hours]

Fundamentals: Optimization Algorithms; Comparison of Different Optimization Algorithms; Genetic Algorithm Source Code and Software; Engine Modeling with Computational Fluid Dynamics; Governing Equations; Physical Models; Numerical Methods; CFD Codes and Software for Engine Simulations; Regression Analysis Methods.

[12 Hours]

Acceleration of Multi-Dimensional Engine Simulation: Method for Reducing Mesh and Time Step Dependency in Engine CFD Modeling; Simulation of Scavenging Process by CFD.

[10 Hours]

Assessment of Optimization and Regression Methods for Engine Optimization: Assessment of Multi-Objective Genetic Algorithms; Assessment of NSGA II; Niching Technique; Convergence and Diversity Metrics; Design- and Objective-Space Niching of NSGA II; Assessment of Regression Methods for Replacing CFD Evaluations. Design, Analysis & Optimization of Piston using CAE & ANSYS.

[12 Hours]

Scaling Laws for Internal Combustion Systems: Introduction; Scaling Laws; Combustion Chamber Geometry; Power Output; Spray Tip Penetration; Flame Lift-Off Length; Swirl Ratio;

[10Hours]

Applications: Engine Optimization with Simple Combustion Models; Internal Combustion Engine; Engine Optimization with Advanced Combustion Models; Advanced electronic-controlled engines (Intelligent Engines).

[10 Hours]

Dual fuel IC engines :

Concept of duel fuel system and combustion process, Duel fuel IC engine, Engine operation and performance with respect to load, Analysis of performance, Additional safety requirements in duel fuel engine.

[8 Hours]

References Books:

1. Hai-Wen Ge, Yu Shi, Rolf D. Reitz "Computational Optimization of Internal Combustion Engines".
2. Heywood JB (1988) Internal Combustion Engine Fundamentals. McCraw-Hill Company, New York.

3. Draper NR, Smith H (1981) Applied regression analysis. John Wiley and Sons, New York.
4. Fonseca CM, Fleming PL (1993) Genetic algorithms for multiobjective optimization. formulation, discussion and generation. Proceeding of the Fifth International Conference on Genetic. Algorithms, Morgan Kaufmann Publishers, Inc, San Meteo, CA.
5. Gen M, Cheng R (1997) Genetic algorithms and engineering designs. Wiley, New York Goldberg DE (1989) Genetic algorithms in search, optimization and machine learning. Addison Wesley, Reading.
6. Gupta HC, Syed SA (1979) REC-P3 (reciprocating engine combustion, planar geometry, third version): A computer program for combustion in reciprocating engines. MAE Report No. 1431, Mechanical and Aerospace Engineering Department, Princeton University.
7. Holland JH (1975) Adaptation in natural and artificial systems. MIT press, Cambridge

Launder BE, Spalding DB (1972) Mathematical models of turbulence. Academic Press, London.

8. Lefebvre AH (1989) Atomization and sprays. Hemisphere, New York Levich VG (1962) Physicochemical hydrodynamics. Prentice-Hall Inc., Englewood Cliffs, NewJersey.
9. MAN B&W's Dual Fuel Marine Engine : A General Overview
10. Sulzer RTA Duel Fuel engines.

SECOND SEMESTER

Sub. Code : MMT/T/202	Instrumentation, Automation, Control & Systems	Hours : 72

Instrumentation Devices

Dynamic characteristics of measurement systems: Transfer function for typical system elements, step and frequency response. Dynamic errors in measurement systems. Techniques for dynamic compensation. Loading effects in measurement system: Electrical loading, generalized loading. Signal and noise in measurement system: Statistical representation of random signals: Effects of Noise and interference on Measurement circuits, Noise sources and coupling mechanism, Method of reducing effects of Noise and interference. [10 Hours]

Sensing Element: Resistive (Potentiometers, Resistance Thermometer, Strain Gauges), Inductive (Variable reluctance, LVDT), Capacitive, Electromagnetic, Thermoplastic, Elastic, Piezoelectric, Photoelectric, Hall effect, Synchros and Resolvers, Digital Displacement Eddy current. Signal Conditioning Circuits: Potentiometer Circuit (Constant voltage and constant current), Wheatstone Bridge (Constant voltage and constant current). [4 hours]
Quadrature encoders, Piezoresistive, MEMS based sensors, accelerometer, gyroscope, pressure sensors [6 Hours]

Industrial Instrumentation:

Pressure Measurement: Characteristics of Measurement Systems: Introduction, Classification, Performance characteristics, Errors; Pressure Measurement: Basic methods, Measurement of mid-range pressures – U-tube manometer, Deadweight gauge, Diaphragm, Bellows, Bourdon tube; Low-pressure measurement – Thermocouple gauge, Perini gauge, Thermostat gauge, McLeod gauge, Ionization gauge; High-pressure measurement; [05 Hours]

Temperature Measurement: Introduction, Thermal expansion methods – Liquid-in-glass thermometer, Bimetallic thermometer, Pressure thermometer; Thermoelectric-effect instruments – Thermocouples; Varying-resistance devices – Resistance thermometers, Thermistors; Radiation thermometers – Optical pyrometers, Radiation pyrometers. [10 Hours]

Flow & Level Measurement : Introduction, Obstruction type flow meters, Variable-area flow meters, Positive-displacement flow meters, Turbine meters, Electromagnetic flow meters, Vortex-shedding flow meters, Ultrasonic flow meters; Dipsticks, Float systems, Pressure-measuring devices, Capacitive devices, Ultrasonic level gauge, Radiation methods, Hot-wire elements, pitot tube, orifice [10 Hours]

Control Systems Engineering:

Introduction: Mathematical Model, Mathematical representation of physical systems, Transfer function and impulse response of linear systems, Block diagram, Signal flow graphs;

General Feedback Theory: Feedback, The effect of feedback, Mathematical definition of feedback; Time Response of Feedback Control Systems: Typical test signal for the transient analysis, time domain performance characteristics, transient response, PI, PD, PID Controllers, Tacho meter feedback, Steady state response, steady state error, The generalized error analysis, Stability, The Routh-Hurwitz criterion;The Root Locus Technique: Introduction, Root Locii, Root locus of conditionally stable systems; [12 Hours]

Frequency Response Analysis:
Frequency domain specifications, Mp and ω_p for a second order system;Gain margin, Phase margin, Relative stability, Bode plot, Polar Plot, Nyquist criterion and stability, conditionally stable systems;

State Variable Analysis: Introduction, state, state variable and state model, State equations of continuous data control system, Derivation of state model from transfer functions and Vice-versa. Diagonalisation, solution of state equation.

[10 Hours]

Control System Components:
Sensors & Transducer, Controller, Amplifier & Actuator
AC servo motors, AC and DC tacho-generators, Hydraulic Systems and Pneumatic Systems onboard ships. [05 Hours]

ReferencesBooks:

1. D.Helfrick, W. D. Cooper, ModernElectronic Instrumentation and Measurement Techniques, PHI, New Delhi, 2002.
2. D. A. Bell, Electronic Instrumentation and Measurement, PHI, New Delhi, 2003.
3. J. P. Bentley, Principles of Measurement System, Pearson Education, Third edition, 2003.
4. E. O. Doebelin, Measurement Systems, Application and Design, McGraw Hill International Edition, Singapore, 2003.
5. D. Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 2000.
6. T. S. Rathore, Digital Measurement Techniques, Naroda Publishing Home, 2001.
7. K. Ogata, Modern Control Engineering, 2001, Prentice Hall of India.
8. N. S. Nise, Control system engineering, 1992, John Wiley & Sons.

SECOND SEMESTER

Sub. Code : MMT/T/203	Marine Environment Protection & Energy Management	Hours : 72

Marine Pollution: Marine pollution problems related to shipping and port development such as ballast water,dredging and spills from ships, and other significant global drivers including population migration to coasts; Pollution, Climate changeand their impact on habitats, biodiversity and economic development.

[06 Hours]

Climate Change: Basic Information;Changes in the Timing of Seasonal Life-Cycle Events; Threshold Effects; Pathogens, Parasites, and Disease; Extinction Risks.

[04 Hours]

International Legal Framework for the Protection of the Marine Environment:
Introduction; International Instruments; 1958 Geneva Conventions; United Nations Conference on Environment and Development; The Marine Protected Area Concept in International Law; International Biodiversity Conventions and Initiatives.

[10 hours]

United Nations Framework Convention on Climate Change (UNFCCC) : Treaty; UNCED; Conference of Parties (COP); Kyoto Protocol; Cancún agreements; Tasks of UNFCCC; Kyoto Protocol- Doha Amendment, Kyoto Mechanism, Monitoring emission targets, Adaptation Fund. PARIS 2015 (COP21- CMP11; MEPC 68; and its impact in shipping; Concerns and challenges of developing countries, particularly from maritime sector. Ballast Water Management 2004 and its onward Regulations. [10 Hours]

The IMO and the International Convention for the prevention of pollution from ships (MARPOL) :

International Convention for the Prevention of Pollution from Ships; Coastal State Versus Flag State Jurisdiction; Flag State Obligations and Jurisdiction; Coastal State Jurisdiction. Various MEPCs and Various Annexes, Annex-VI interalia.

[14 Hours]

Energy Management : Sources of Energy Supply and Energy Demands; Combined Cycles; Combined heat and power cycle (co-generation cycle); Energy management and Energy Audits; The Technology of Energy savings,Renewable Energy Sources.

[06 Hours]

ISO 50001:2011 standard requirements ; Audit protocol for ISO 50001:2011; Requirement for Energy Management Systems (EnMS); Review of ISO 50001:2011 system and ISO 19011:2002 : Requirements; Critical Success Factors. [06 Hours]

Design of Energy Efficient Vessels; Maintenance, Measurement and Management strategies towards sustainable development; Innovations including usage of sustainable marine renewable energy resources to tap into the power of the wind, solar, wave, OTEC and tidal energy. Reduction of Carbon dioxide emission – Regulation vs Responsibility [Corporate Social Responsibility (CSR)]; Energy efficiency calculations for a complete power generation plant. Fuel management and energy efficiency technologies and operational practices. Ship Energy Efficiency Management Plan (SEEMP); Energy Efficiency Operational Indicator (EEOI); Energy Efficiency Design Index (EEDI); Compliance timeframes and issues; Market based measures (MBMs) for GHG reduction.

[16 Hours]

Reference Books :

1. Marine Environment Protection and Biodiversity Conservation: The Application and Future Development of the IMO's Particularly Sensitive Sea Area Concept--Roberts, Julian (SPRINGER)
2. Prevention of Pollution of the Marine Environment from Vessels: The Potential and Limits of the International Maritime Organisation- Karim, Md Saiful
3. Marine Environment Protection: Essays– Muzhen Lu
4. Handbook on Energy Audit and Environment Management-- Y P Abbi
5. Handbook of Energy Audits-- Albert Thumann , Terry Niehus , William J. Younger
6. Commentary on MARPOL –Volume A & B- Bhandarkar Publications
7. MARPOL – Consolidated Edition
8. Guidelines For The Control And Management Of Ships' Biofouling to Minimize The Transfer Of Invasive Aquatic Species
9. Pollution Prevention Equipment under MARPOL
10. Provisions Concerning the Reporting of Incidents Involving Harmful Substances Under MARPOL
11. London Convention and Protocol: Guidance for the Development of Action- IMO
12. OPRC-HNS Protocol 2000- IMO
13. Guidelines for The Development Of Shipboard Marine Pollution Emergency Plans- IMO
14. Guidelines for Ensuring the adequacy of Port Waste Reception Facilities- IMO
15. Guidelines for The Control and Management Of Ships' Ballast Water to Minimize The Transfer Of Harmful Aquatic Organisms and Pathogens- IMO
16. International Convention on The Control Of Harmful Anti-Fouling Systems (AFS) on Ships, 2001 –IMO
17. Shipping and the Environment - A Code of Practice-- International Chamber of Shipping
18. Guidelines for the Preparation of Garbage Management Plans - A Code of Practice -- International Chamber of Shipping
19. International Safety Guide for Oil Tankers and Terminals-Edited by International Chamber of Shipping- ISGOTT

SECOND SEMESTER

Sub. Code : MMT/TE/XXX	Elective	Hours : 72

SECOND SEMESTER
ELECTIVE

Sub. Code : MMT/TE/201	Cryogenic and LNG Vessels	Hours : 72

Introduction: Cryophysics, Matter at low temperatures, Specific heat, Thermal conductivity, Electrical conductivity, Magnetic and mechanical properties, Production of Low Temperatures, Linde Hampson and Claude cycles and their derivatives, Cryogenic fluids, Properties of Cryogenic fluids, Properties of frost in Cryogenic temperatures. [10Hours]

Heat Transfer in Cryogenic system: Conductive Heat Transfer, Governing equation, Generalised solution of steady and unsteady conduction equations, Heat transfer through composites and materials of variable thermal properties, Conduction in fins, Heat leakage and Cooling down losses. Convective Heat Transfer, Evaluation of heat transfer and friction coefficients for Turbulent and Laminar flow, Natural convection and near critical heat transfer regions, Two Phase Phenomena, Physical description, Pool boiling, Critical heat flux, Pressure drop of Two Phase fluid, Forced convection with Two Phase flow, Superfluid heat transfer, Kapitza Resistance.
Radiation, Shape factor, Radiation exchange between two grey surfaces, Network method for enclosures, Radiation from LNG fins, Free molecular heat transfer in enclosures.
[20 Hours]

Insulations: Cryogenic insulation, methods of thermal insulation, selection of insulating materials, vacuum insulated containers, multi-layered insulated systems, using aluminium foil, fibre glass paper spacers, evacuated powders or fibres, other insulation systems using glass fibre and silica aerogel.
[10 Hours]

Cryogenic Heat Exchangers: Cryogenic heat exchangers types- tubular, Giauque Hompson, plate fin, Perforated and sintered metal powder heat exchangers, Heat transfer correlation near critical region, Kapliza conductance, NTU effectiveness design methods, Giauque Hompson heat exchange design, Plate fin heat exchanger design, Perforated plate heat exchanger design, Effects of variable sp. heats, Effects of longitudinal heat conduction, Effect of heat transfer from ambient, Regenerators design. [12 Hours]

Cryogenic Refrigeration Systems: Ideal isothermal and isobaric source systems, Joule Thomson systems, Pre-cooled Joule Thomson system, Philips refrigerator, G-Mrefrigerator, Pulse Tube refrigerator, Liquefaction systems, Ideal, Cascade, Use of refrigerated system for LNG cargo.
[10 Hours]

LNG Vessel: Type of ships (LNG), Type of Tanks, Tank arrangements, LNG cargo loading and discharging, Drying of hold spaces, Tank atmosphere evaluation, Gassing up of cargo tanks and lines, Cooling down of Cryogenic fluid storage vessel, LNG Vaporizers and Forcing Vaporizers, Inerting of cargo tanks and pipelines, N2 use in LNG vessel, control and monitoringof Cargo handling system, ESD operation, Compressor & motor room safety.
[10 Hours]

Reference Books:

1. Cryogenic Heat Transfer, Randall F Barron, series in Chemical and Mechanical Engineering.
2. Principles of Refrigeration, Gosney W B, Cambridge University Press
3. Fundamentals of heat and mass transfer, Incropera, Dewitt, Bergman and Lavine, John Wiley & sons Inc.
4. Convection heat transfer, Bejan, John Wiley & sons Inc.
5. Code for the Construction and Equipment of ships carrying LiquefiedGases in Bulk, as amended (IMO-782).
6. International Code for the Construction and Equipment of shipscarrying Liquefied Gases in Bulk (IGC Code) (IMO-104).
7. Liquefied Gas Handling Principles an ships and in Terminals by Mcguire & White (SIGTTO) (London, Witherby Marine Publishing) (ISBN 1 85609-087 6).
8. Gas Transportation and Storage by Alan Vaudolon.
9. Safe Gas Tanker Operations Capt. KSD Mistree & Mr. B.K. Sharma.

SECOND SEMESTER
ELECTIVE

Sub. Code : MMT/TE/202	Electrical Machines and Power Electronic Systems	Hours : 72

High Voltage System: Requirements of classification societies, mandatory rules with/without earthing, interference with control system, safe practice while watch keeping and maintenance, switching and isolation procedure, various circuit breakers, lay out of system, rating of switch gear. [10 Hours]

Propulsion Systems: Comparisons between Electric, Steam and Diesel driven propulsion systems, DC Propulsion motors: Constant Voltage Propulsion system, Induction propulsion motors, High Temperature Super-conducting motors, Harmonics. [10 Hours]

Fundamentals of Designmethods: Fundamentals of design methods of Electrical machines and Power Electronics systems. **Design Methods**: Design methods for electro-mechanical system design; Analytical and computer simulation methods in their analysis. [10 Hours]

Analysis and Calculation: Analysis of constant and variable speed electrical drive systems to calculate key parameters by Thyristor and Electric Sensors such as torque, speed, efficiency, and power under steady-state and transient conditions [10 Hours]

Fuzzy Controllers and Fuzzy Neural Controller: Controller- Generation of PWM signals, sinusoidal pulse width modulation, ADC and DAC interface, Assemblers and assembly language programming, Fuzzy Logic and Computations using Fuzzy Controller; Artificial Neural Network modelling, computation using ANN Tools including Fuzzy Neural controller, case study . [12 Hours]

Simulation Tools: Computer based simulation tools to analyse electrical machine and power electronic system behaviour with an understanding of the mathematical algorithms upon which such tools are based. [10 Hours]

Materials: State of the art in electrical machines and power electronic systems and advanced materials and topologies influencing future designs. [10 Hours]

Reference Books:

1. Electrical Machines, Drives and Power Systems Theodre Wildi, Prentice Hall
2. Programmable Logic Control- Theory and Implementation - L.A Bryan and E.A.Bryan.
3. Fuzzy Neural Control – Principles, Algorithms and Applications- Junhong Nie and Derek A.Linkens

Web resources: www.plcprofessor.com, www.siemens.com, www.rockwell.com

SECOND SEMESTER

Sub. Code : MMT/T/205	Financial Management and Cost Accounting	Hours : 72

Introduction to Financial Management

Scope of Finance, Finance Function and Goal - Organization of Finance Function – Concept of Value, Risk & Return – Capital Budgeting; Payback, Discounted Payback, Accounting Rate of Return (ARR), Internal Rate of Return (IRR), Net Present Value (NPV) and Profitability Index (PI) - Basics of Bonds and Shares Valuation.

[15 Hours]

Financing and Dividend Decisions

Sources of finance - Analysis of Leverage – Cost of Capital (WACC Computation) - Determinants of Capital Structure – Trade off Theory - Pecking Order Theory – Dividend Theories – Forms of Dividends – Venture Capital Financing – Financing Large Projects.

[15 Hours]

Analysis and Interpretation of Financial Statements

Income Statement, Balance Sheet and Cash Flow Statement - Users of Financial Statements – Types of Ratio; Liquidity, Leverage Activity and Profitability ratios – Trend Analysis – Inter Firm Analysis – Dupont Ratio Analysis – Analysis of Financial Statements of port/shipping companies - Utility, Limitation and Cautions in using Financial Statements.

[15 Hours]

Cost Accounting

Cost Accounting Meaning, Objectives and Scope - Concepts of Costs, Classifications and Elements of Cost - Cost Centre and Cost Unit - Methods and Techniques of Costing; Job and Batch Costing – Break Even Analysis and Margin of Safety.

[12 Hours]

Marginal and Absorption Costing, Standard Costing and Variance Analysis

Difference between Marginal Costing and Absorption Costing – Meaning of Standard Cost - Variance Analysis for Materials, Labour and Overheads – Comparison between Budgeting and Standard Costing - Benchmarking for Setting of Standards.

[15 Hours]

Reference Book:

1. I.M. PANDEY, (2015),Financial Management –11th Edition - Vikas Publications
2. ICSI Module (https://www.icsi.edu/docs/webmodules/Publications/2.%20CMA-Executive.pdf)
3. REDDY, T. S., & HARI, P. R., *Financial and Management Accounting.* Margham publications
4. MAHESHWARI, S. N., (2013) *Cost and Management Accounting.* 14th edition

SECOND SEMESTER

Sub. Code : MMT/T/ 206	Management Information System (MIS)	Hours : 72

Introduction to Information Technology

Impacts of IT on Individuals, Organizations and Society-Information Technology Developments and Trends (Social Media, Virtual Reality)-IT Support Systems- Classification and Types of Information Systems-IT Infrastructure and Architecture- Emerging Computing Environments.

[12Hours]

Database Management and Analytics

File Management-Database Management Systems- Creating Databases- Data Warehousing- Web-based Data Management Systems-Big Data- Basic overview of Oracle/SQL. Business Analytics, Online Analytical Processing, Reporting and Querying- Data, Text, Web Mining and Predictive Analytics- Data Visualization, Geographical Information Systems and Virtual Reality-Marketing Databases in Action.

[15 Hours]

Enterprise Information System

Need for ERP –Challenges and Opportunities- Business Process Management using ERP - Customer Relationship Management- Virtual Corporations- Cloud Computing- Global Information Systems-RFID-E-Commerce -Fleet MIS-Application: basic SAP Tutorial

[15 Hours]

Managerial and Decision Support Systems

Knowledge Management Systems Implementation-Real-time Business Intelligence and Competitive Intelligence-Business Performance Management, Scorecards and Dashboards- Types of Decision Support Systems-Automated Decision Support (ADS) - Expert Systems-Application: case studies

[15 Hours]

Establishing and Managing IT Security

Securing the enterprise; IS Vulnerabilities and Threats- Fraud and Computer Crimes- IT Security Management Practices-Network Security- Internal Control and Compliance Management- Business Continuity and Disaster Recovery Planning- Implementing Security: Auditing and Risk Management- Computer Forensics- Managerial issues-National Cyber-security Policy, 2013-IT issues Ethics and Responsible Conduct.

[15 Hours]

Reference Books:

1. EFRAIM TURBAN, et al. (2013) Information Technology Management, 6th Edition – Wiley: New Delhi.
2. KENNETH C. L., JANE P. L., & RAJANISH DASS (2001) Management Information System - Managing the Digital Firm. Pearson Education: New Delhi.
3. RAVI, K., & ANDREW, B. W. Frontiers of Electronic Commerce. Pearson Education: New Delhi.
4. SADAGOPAN, S. (2003) Management Information System. Prentice Hall India: New Delhi
5. EFF, O.Z. (2003) Management Information Systems. Vikas Publishing House Pvt. Ltd.: New Delhi.
6. JAMES A O' BRAIN, (1999) Management Information Systems. Tata Mc Graw Hill: New Delhi.

7. Management Information System (MIS): Lodan &Lodan

SECOND SEMESTER

Practical / Laboratory

MMT/P/201	Control Systems Laboratory	Hours : 54

Control Systems

(1) Use of MATLAB, Simulink for Control Systems
   (a) Part I: Introduction to MATLAB
   (b) Part II: Polynomials in MATLAB
   (c) Part III: Scripts, Functions & Flow Control in MATLAB

(2) Mathematical Modeling of Physical Systems
   (a) Mass-Spring System Model
   (b) Speed Cruise Control example
   (c) Mass-Spring System example
   (d) Exercise

(3) Linear Time Invariant Systems and Representation
   (a) Mass-Spring System Model
   (b) Transfer Function
   (c) Linear Time-Invariant Systems in MATLAB
   (d) Examples of Creating LTI Models
   (e) Simulation of Linear systems to different inputs
   (f) Exercise

(4) Block Diagram Reduction

(5) Performance of first order and second order systems

SECOND SEMESTER

Practical / Laboratory

Sub. Code : MMT/P/202	CFD	Hours : 54

I.

1. CFD tools Operations
2. Ship based equipment design
3. Optimization using CFD by iterations
4. Parametric optimization using CFD
5. Mathematical modeling of mechanical, hydraulic and electrical systems

II. CFD Modeling: Simulation of Combustion and Scavenging processes in IC Engines