Detailed Syllabus

Bachelors of Technology Programme in Naval Architecture & Ocean Engineering

Version 2

(Applicable to regular batches admitted from Academic Year 2019-20 onwards and lateral entry batches admitted from Academic Year 2020-21 onwards)

Table of Contents

SEMESTER 1

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Engineering Mathematics-I	BS	3	2	1	0	3
T	Engineering Physics	BS	3	3	0	0	3
T	Engineering Chemistry	BS	3	3	0	0	3
T	Computer Programming	ES	3	3	0	0	3
P	Engineering Graphics	ES	3	1	0	4	5
P	Physics Laboratory	BS	1	0	0	2	2
P	Chemistry Laboratory	BS	1	0	0	2	2
P	English Language Lab	MC	0	0	0	3	3
P	Extra Academic Activity 1	MC	0	0	0	4	4
			17				28

	Engineering Mathematics I	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To acquaint the students with Mathematical tools needed in engineering fields.

Unit - I: Mean Value Theorem 7 Hrs

Rolle's Theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders. Indeterminate forms - Concavity and convexity of a curve, points of inflexion - asymptotes and curvature.

Unit - II: Differential calculus of several variables 15 Hrs

Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobean and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

First order differential equations - exact linear and Bernoulli's form - Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

Unit – III: Analytic Functions & Complex Integration 17 Hrs

Functions of a complex variable – Analytic functions Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz, $1/z$, z^2, e^Z and bilinear transformation

Complex integration – Statement and applications of Cauchy's integral Theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue Theorem – Evaluation of real definite integrals as contour integrals around unit circle

and semi-circle (excluding poles on the real axis).

Unit - IV: Sequences and series **7 Hrs**

Sequences Definition and examples – Series Types and Convergence – Series of positive terms – Tests of convergence Comparison test, Integral test and D' Alembert's ratio test – Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

Unit – V: Multiple Integrals **8 Hrs**

Double integrals in Cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves. Change of variables in double integrals – Area of a curved surface – Triple integrals – Volume of Solids.

Text Books

1. GREWAL B.S., (2011), *Higher Engineering Mathematics*, Khanna Publications, New Delhi.
2. RAMANA B.V., (2008), *Higher Engineering Mathematics*, Tata McGraw Hill, Publishing Company, New York, USA

Reference Books

1. DASS H.K. & RAJNISH VERMA E.R., (2011), *Higher Engineering Mathematics*, S. Chand Private Ltd, New Delhi.
2. GLYN JAMES, (2012), *Advanced Modern Engineering Mathematics*, Pearson Education, India.
3. PETER V. O'NEIL, (2012), *Advanced Engineering Mathematics*, Cengage learning.
4. JAIN R.K. & IYENGAR S.R.K, (2007), *Advanced Engineering Mathematics*, Alpha Science International, Oxford.
5. ERWIN KREYSZIG, (2010), *Advanced Engineering Mathematics*, Wiley International, New Jersey.

	Engineering Physics	L	T	P	C	Hrs
		3	0	0	3	54

Objective: A basic course in understanding of concepts in heat, optics, waves, electromagnetism and fundamental properties of materials, with relevant applications.

Unit-I: Heat **9 Hrs**

Thermodynamics: Isothermal expansion of a gas- adiabatic expansion of a gas- change in internal energy of a gas or general gas equation- relation between pressure and volume in a adiabatic process- different forms of adiabatic equation- adiabatic curves are steeper than isothermal curves- work done by a gas in isothermal expansion- work done by a gas during adiabatic expansion- compressibility of a gas.

Transmission of heat: Modes of transmission of heat- convection- radiation- laws of black body radiations.

Unit-II: Optics **12 Hrs**

Optical instruments: microscope & telescope - sextant - spectrometer. Interference: Young's experiment - fringes - conditions for interference - types of interference - Fresnel's bi-prism.

Diffraction: difference between interference and diffraction - determination of wavelength by straight edge - resultant of 'n' simple harmonic motions

Polarization: Polarization of light waves - representation of various types of light - plane of polarization - theory of photo-elasticity

LASER: Lasers - spontaneous and stimulated emission - types of lasers – ruby laser - gas laser - semiconductor laser - CO_2 laser - uses of laser.

Unit-III: Waves **15 Hrs**

Wave motion: Wave motion - types of wave motion and characteristics of wave motion - definitions of important terms - relations between various terms - sound as a wave - phase velocity - wave velocity - equation of plane

progressive wave - particle velocity and wave velocity - differential equation of wave motion - distribution of velocity and pressure in progressive wave - energy of the progressive wave - absorption and attenuation of waves.

Superposition of waves: Principle of superposition of waves - interference of sound waves - stationary waves - beats - stationary waves - Lissajous figures and their significance - group velocity and phase velocity.

Transverse vibrations of stretched strings: Velocity of transverse waves along stretched string - frequency of a vibrating string - harmonics and overtones.

Doppler's principle: Doppler's effect - applications of Doppler's principle

Acoustics of buildings: Basic requirement for acoustically good halls - reverberation and time of reverberation - Sabine's formula - absorption coefficient and its measurement - transmission of sound and transmission loss - factors affecting architectural acoustics - sound absorbing materials.

Ultrasonics: Ultrasonic waves - production of ultrasonic waves - detection of ultrasonics - properties of ultrasonics - wavelength of ultrasonic - waves - application of ultrasonic waves.

Unit-IV: Electro-magnetism 9 Hrs

Thermo-electricity: Seebeck effect - variation of thermoelectric e.m.f with temperature - Thermo-electric series - law of successive contacts , temperatures - Peltier effect - Thomson effect - total e.m.f in thermocouple - thermo-electric power - applications of thermoelectric effect

Maxwell's equation & electromagnetic waves: Vector fields – rotational and irrotational - source and sinks in vector fields - divergence theorem - basic laws of electricity and magnetism in differential form - oscillations - charge conservation law - continuity equation - displacement current - Maxwell's equations - electromagnetic waves in free space - Poynting vector - propagation of electromagnetic waves in dielectric field and through conducting media.

Unit-V: Material properties **9 Hrs**

Crystal structure: Space lattice - basis of crystal structure - unit cell - crystal systems - Bravais space lattices - classification of crystal based on nature of forces - number of atoms per unit cell - coordination number - atomic radius - packing density - calculation of lattice constant - lattice planes and Miller indices - separation between lattice planes in simple - face-centered and body-centered lattices.

Classification of solids (metals - insulators - semiconductors - superconductors):Energy levels in solids - valence band - conduction band and forbidden band - conductors - semi-conductors and insulators - chemical bonds in semi-conductors like - Ge and Si - intrinsic and extrinsic semi-conductors - impurity semi-conductors - conductivity of semi-conductor - P-N junction diode - junction transistors - superconductivity - superconductors and their properties - types of superconductors - theories on superconductivity.

Text Books

1. GAUR R.K. & GUPTA S.L., (2015), *Engineering Physics*, Dhanpat Rai Publications, New Delhi.
2. AVADHANULU M.N. & KSHIRSAGAR P.G., (1992), *A Textbook of Engineering Physics*, S. Chand Publishing, New Delhi.

Reference Books

1. RESNICK. R, HALLIDAY. D & KRANE. K.S., (2007), *Physics vol 1 & 2*, John Wiley & Sons,
2. PALANISAMY P.K., (2009), *Engineering Physics*, SciTech Publications Pvt Ltd, Chennai.
3. THERAJA B.L., (2008), *Modern Physics*, S. Chand Publishing, New Delhi.
4. BHATTACHARYA, BHASKARAN, (2010), *Engineering Physics*, Oxford Publications, Oxford.

	Engineering Chemistry	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To introduce the student to the basic concepts of Chemistry in engineering applications.

Unit – I: Water and its Treatment **12 Hrs**

Source of water - hard and soft water - determination of hardness - softening water ion exchange process. Boiler feed water operation - caustic embrittlement - internal conditioning. Water for domestic purposes – sedimentation – coagulation - filtration and sterilization - chlorination and its advantages and disadvantages. Disinfection with Ozone. Desalination Pollution – chemical characteristics - sewage treatment biological oxygen demand (BOD) - chemical oxygen demand (COD) - total dissolved solids (TDS).

Unit- II: Energy sources **12 Hrs**

Solid, liquid and gaseous fuels - calorific value of fuels - calorific intensity. Coal – analysis of coal - carbonization of coal - metallurgical coke and its manufacture - hydrogenation of coal. Petroleum Origin and refining of petroleum - cracking and polymerization - requisites of a good petrol. Diesel oil – Petrochemicals - Gaseous fuels - natural gas – LPG - Producer gas - combustion zone - reduction zone, water gas - Batteries and fuel cells - Types of batteries- alkaline battery- lead storage battery- nickel-cadmium battery- fuel cell H_2 -O_2 fuel cell- applications.

Unit-III: Engineering Materials **12 Hrs**

Lubricants -Introduction -Mechanism of lubricants –Classification – Properties of lubricants - Refractories – Manufacturing – Properties – Classification etc. -Glass – Introduction- Properties of glass –Manufacturing of glass & their types - Cement –Introduction – Manufacturing –Gypsum – Mortar and concretes

Unit – IV: Electrochemistry 9 Hrs

Introduction –Electrolysis – Conductance –Conductometric titrations – Electrochemical cells – EMF –Measurement of EMF-Applications of EMF – Reference Electrodes-Hydrogen electrode –Calomel electrode –Nernst equations etc.,

Unit – IV: Environmental Chemistry 9 Hrs

Composition of atmosphere – chemical and petrochemical reactions – Green House effect – composition of lithosphere – wastes and pollutants in soil – impact of toxic chemicals in the environment – air pollution – water pollution – quality parameters and standards

Text Books

1. NKRISHNAMURTHY, VALLINAYAGAM D.MADHAVAN (2014) *Engineering Chemistry 3rd Edition*, PHI learning Pvt Ltd Eastern Economy Edition, New Delhi.
2. OG PALANNA (2009) *Engineering Chemistry,* Tata Mc Graw Hill Education Private Limited New Delhi.

Reference Books

1. JAIN & JAIN (2016) *Engineering Chemistry (16th Edition)*, Dhanpat Rai, New Delhi.
2. SHASHI CHAWLA (2006) *A text Book of Engineering Chemistry 3rd Edition*, Dhanpat Rai, New Delhi.
3. A.K. DE (2008) *Environmental Chemistry,* New Age International P. Ltd Publishers, New Delhi.
4. K.S. VENKATESWARLU (2005) *Water Chemistry*, New Age International P. Ltd Publishers, New Delhi

	Computer Programing	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To introduce the student on basics of computing and programming language - C

Unit – I: Introduction **10 Hrs**

Introduction to computer organization; Evolution of Operating Systems; Machine languages, Assembly Languages and High Level Languages; Key Software and Hardware Trends, Procedural & Object Oriented Programming Methodologies; Program Development in C, Structured Programming - Algorithm, Pseudo-code; The C Standard Library, Data types in C, Arithmetic operators, Control Structures – If-else, While, for, do-while, Switch, break and continue statements; Formatted input-output for printing Integers, floating point numbers, characters and strings; Simple C Programming examples

Unit -II: Designing Structured Programs in C **12 Hrs**

Top Down Design and Stepwise refinement; Program Modules in C, Math Library Functions, Function Definition, Prototypes; Header files, Parameter passing in C, Call by Value and Call by Reference; Standard functions, Recursive functions, Pre-processor commands, Example C programs; Scope, Storage classes; Arrays covering, Declaring arrays in C, Passing arrays to functions, Array applications, Two – dimensional arrays, Multidimensional arrays, C program examples;

Unit - III: Pointers in C **10 Hrs**

Pointer variable declaration and Initialization. Pointer operators, Pointer expressions and Arithmetic, Relationship between pointers and arrays; Strings including Concepts, String Conversion functions, C Strings, String Manipulation Functions and String Handling Library;

Unit–IV: Derived types **12 Hrs**

Structures – Declaration, definition and initialization of structures, accessing structures, structures in functions, self-referential structures, unions; Data Structures including Introduction to Data Structures, Stacks, Queues, Trees, representation using arrays, Insertion and deletion operations;

Unit - V: Dynamic Memory Allocation **10 Hrs**

Linked List Implementation, Insertion, Deletion and Searching operations on linear list; Searching and Sorting – Sorting- selection sort, bubble sort, insertion sort, quick sort, merge sort, Searching-linear and binary search methods

Text Books

1. RAJARAMAN V & ADABALA N, (2014), *Computer Fundamentals*, Prentice Hall India Learning Pvt. Ltd.
2. KERNIGHAN.B.W & DENNIS RITCHIE, (2015), *The C Programming Language*, Second Edition, Pearson Education India.

Reference Books

1. BYRON GOTTFRIED, (2010), *Programming with C*, Third Edition, Tata McGraw Hill Education.
2. R.G.DROMEY, (2001), *How to Solve it by Computers*, Prentice-Hall.
3. J.R. HANLY & E.B. KOFFMANN, (2009), *Problem Solving and Program Design in C*, Sixth Edition, Pearson Education.
4. PAUL DEITAL & HARVEY DEITAL, (2012), *C How to Program*, Seventh Edition, Prentice-Hall.
5. YASHAVANT KANETKAR, (2012), *Let Us C*, twelfth Edition, BPB Publications.

	Engineering Graphics	L	T	P	C	Hrs
		1	0	4	3	90

Objective: To provide the basic knowledge about Engineering Drawing - projections, technical drawing, views, dimensioning and specifications, useful for an engineering career.

Unit - I: Introduction to Engineering Drawing 9 Hrs

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Unit - II: Orthographic Projections covering, 24 Hrs

Principles of Orthographic Projections Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Unit - III: Projections of Regular Solids 24 Hrs

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views;

Unit - IV: Sections and Sectional Views 9 Hrs

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone;

Unit - V: Isometric Projections 24 Hrs

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Text Books

1. BASANT AGARWAL, CM AGARWAL (2008), *Engineering Drawing* TMH education Pvt ltd, New Delhi
2. Bhatt N D and V M PANCHAL (2016) *Engineering Drawing*, Charotar Publishers.

Reference Books

1. SHAH M B and B C RANA (2009) *Engineering Drawing.* Ed. 2. Pearson Publishers
2. JEYAPOOVAN T (2015) *Engineering Graphics using Auto CAD,* VIKAS Publishing House.
3. BHATT, N.D (2016) *Engineering Drawing Plane and Geometry*, Charotar Publishing House
4. GILL P S (2014) Engineering Drawing, Kataria & Sons.

	Physics Laboratory	L	T	P	C	Hrs
		0	0	2	1	36

Physics

1. Torsional Pendulum Rigidity Modulus
2. Normal modes of coupled oscillators
3. Measurement of velocity of acoustic waves
4. Newton’s rings
5. Specific rotation of an optically active source
6. Diffraction with laser
7. Dispersive power of a prism
8. Fresnel Bi prism
9. Franck Hertz experiment
10. Photoelectric effect
11. Energy gap of a material of P -N Junction
12. Measurement of Hall effect

	Chemistry Laboratory	L	T	P	C	Hrs
		0	0	2	1	36

Chemistry

1. Estimation of Chloride ion using Argentometric method
2. Estimation of hardness of water by using EDTA method
3. Estimation of Alkalinity
4. Estimation of Dissolved oxygen by using Iodometric Titration (Winkler's method)
5. Estimation of Phosphate
6. Conductometric titration of strong acid vs. strong base (HCl vs. NaOH)
7. Estimation of ferrous sulphate by using permanganometric titrations
8. Determination of Viscosity of a lubricating oil using Red wood Viscometer
9. Estimation of Hydrazine by using Iodimetric Titration
10. Estimation of sulphate by using Conductometric titrations

	English Language Lab	L	T	P	C	Hrs
		0	0	3	0	54

English Language LAB course focussed on Development of oral, Written and communication skills.

SEMESTER 2

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Engineering Mathematics-II	BS	3	2	1	0	3
T	Applied Mechanics	ES	3	2	1	0	3
T	Applied Thermodynamics	ES	3	2	1	0	3
T	Basic Electrical Engineering	ES	3	2	1	0	3
T	Environmental Studies	HS	2	2	0	0	2
P	Workshop Practice I	ES	2	1	0	2	3
P	Basic Electrical Engineering Laboratory.	ES	1	0	0	2	2
P	Computer aided Drafting and Modeling.	ES	1	0	0	2	2
P	Computer Programming & Simulation Laboratory.	ES	1	0	0	2	2
P	Extra Academic Activity 2.	MC	0	0	0	2	2
			19				25

	Engineering Mathematics-II	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To provide the basic knowledge for solving Partial differential equations, Transformations and vector calculus.

Unit – I: Matrices **11 Hrs**

Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigen vectors – Statement and applications of Cayley - Hamilton Theorem – Diagonalization of matrices – Reduction of quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

Unit - II: Vector Calculus **11 Hrs**

Gradient - divergence and curl–Directional derivative – irrotational and solenoid vector fields – Vector integration – Green's theorem in a plane - Gauss divergence theorem and Stokes' theorem (excluding proofs) –Simple applications involving cubes and rectangular parallelepipeds.

Unit - III: Laplace Transform **14 Hrs**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions – Derivatives and integrals of transforms –Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform – Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques - Fourier series Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis

Unit - IV: Partial Differential Equations **10 Hrs**

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations - Lagrange's

linear equation – Linear partial differential equations of second and higher order with constant coefficients of both Homogeneous and non - homogeneous types and Applications

Unit - V: Fourier Transforms 8 Hrs

Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Text Books

1. BALI N. P & MANISH GOYAL, (2011), *A Text book of Engineering Mathematics*, Laxmi Publications Pvt Ltd, New Delhi.
2. GREWAL B.S, (2011), *Higher Engineering Mathematics*, Khanna Publications, New Delhi.

Reference Books

1. SIVARAMA KRISHNA DAS P. & RUKMANGADACHARI E., (2011) *Engineering Mathematics Volume II*, PEARSON Publishing, London, UK.
2. PETER V. O'NEIL, (2012), *Advanced Engineering Mathematics, 7th Edition*, Cengage learning, Boston, USA.
3. GLYN JAMES, (2012), *Advanced Modern Engineering Mathematics, 3rd Edition*, Pearson Education, London, UK.
4. ERWIN KREYSZIG, (2010), *Advanced Engineering Mathematics*, Wiley International, New Jersey

	Applied Mechanics	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To impart the fundamental principles of equilibrium of bodies under action of forces and apply the same to physical systems.

Unit-I: Introduction to Engineering Mechanics 11 Hrs

Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and concurrent coplanar forces, resultant of coplanar force systems, couple, moment of a force, Varignon's theorem, concept of free body diagrams, concept of equilibrium of coplanar force systems.

Friction: Laws of friction, types of friction, equilibrium of force systems involving frictional forces, wedge friction.

Unit-II: Geometric Properties 10 Hrs

Properties of Surfaces and Volumes: Centroid and centre of gravity, derivation of centroids from first moment of area, centroids of composite sections, centre of gravity of common volumes - cylinder, cone, sphere, theorem of Pappus.

Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, mass moment of inertia of common volumes -thin plates, thin rod, cylinder, cone, sphere, rectangular prism, radius of gyration.

Unit-III: Structures Analysis 11 Hrs

Analysis of Structures: Introduction to plane trusses, analysis of plane trusses by method of joints and method of sections.

Virtual Work: Equilibrium of ideal systems, work done by a force, work done by a couple, principle of virtual work.

Unit-IV: Kinetics **11 Hrs**

Kinetics: Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, principle of work and energy.
Ideal Systems: Principle of conservation of energy, concept of power, conservation of linear and angular momentum, principle of momentum and impulse, impact - types of impact.

Unit-V: Kinematics **11 Hrs**

Equations of motion for rigid bodies, constant and variable acceleration, rectilinear and curvilinear motion, motion under gravity -projectile motion, use of rectangular coordinates, tangential and normal coordinates, radius of curvature, rotation of a rigid body about a fixed axis, introduction to plane motion.

Text Books

1. TIMOSHENKO S., YOUNG D.H, RAO J. V., (2008), *Engineering Mechanics*, Tata McGraw Hill, USA.
2. KUMAR K.L., (2010), *Engineering Mechanics*, Tata McGraw Hill, USA.

Reference Books

1. FERDINAND BEER, E. RUSSELL JOHNSTON, JR., DAVID MAZUREK, PHILLIP CORNWELL, (2012), *Vector Mechanics for Engineers: Statics & Dynamics*, McGraw Hill Higher Education, USA.
2. BHAVIKATTI S.S., (2008), *Engineering Mechanics*, New Age International Publishers, New Delhi.
3. LAKSHAMANA RAO C., LAKSHMINARASIMHAN J., SETHURAMAN RAJU, SRINIVASAN M. SIVAKUMAR, (2003), *Engineering Mechanics: Statics and Dynamics*, Prentice Hall of India, New Delhi.
4. SHARMA D.P., (2010), *Engineering Mechanics*, Pearson Education, UK.

	Applied Thermodynamics	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To understand the principles, laws and properties associated with thermodynamic variables and apply the same to physical systems.

Unit-I: Entropy **12 Hrs**

Definition – Laws of Thermodynamics - Principles of increase of entropy - calculation entropy for various processes - Available Energy and Availability - Helmholtz and Gibbs functions - Availability in steady flow - Entropy equation for flow processes – irreversibility.

Unit-II: Thermal Cycles **12 Hrs**

Properties of Pure Substances - Definitions - p-V, p-T, T-s and h-s diagrams for a pure substance - quality – Steam Tables - Charts for thermodynamics properties - Measurement of steam quality - Vapour Power Cycles - Rankine cycle - Comparison of Rankine and Carnot vapour cycles - Regenerative cycles - Ideal working fluid for vapour power cycles.

Unit-III: Internal Combustion Engines and Compressors 12 Hrs

Air standard Otto - Diesel and Dual cycles - C. I. and S. I. engines - Four stroke and two stroke cycles - Indicated Power - Brake Power - Mechanical - Thermal and relative efficiencies. Valve timing Diagram. Gas turbine basic cycle- Brayton cycle - work done and efficiency. Stirling cycle - work done and efficiency

Air compressors: Working principles of reciprocating air compressors - volumetric efficiency - effect of clearance - single and multistage compressors with intercooling - optimum inter-stage pressure - air motors and other application of compressed air.

Unit-IV: Heat exchangers **6 Hrs**

types of heat exchangers and construction - basic heat exchanger flow arrangements – parallel - counter flow - mixed - multi-pass flow exchangers - heat transfer concepts - fouling - LMTD - effectiveness-NTU method

Unit-V: Refrigeration & Air-conditioning **12 Hrs**

Basic concept of vapour compression cycle - components of the vapour compression refrigeration system - refrigerants and their properties.

Need for air conditioning - comfort zone - use of psychrometric charts - basic air conditioning cycle - components of the system - components in AHU's various types of a.c systems - important factors for calculating the cooling load requirement.

Text Books

1. NAG P.K., (2010), *Basic & Applied* Thermodynamics, Tata McGraw Hill, New York, USA.
2. RAJPUT R.K, (2009), *Applied Thermodynamics*, Laxmi Publications, New Delhi.

Reference Books

1. EASTOP T.D, MCCONKEY A., (2009), *Applied Thermodynamics for Engineering Technologists*, Pearson Education, London, UK.
2. BOLES MICHAEL, CENGL YUNUS (2014), *Thermodynamics: An Engineering Approach*, McGraw Hill Education, New York, USA.
3. MICHAEL J. MORAN, HOWARD N. SHAPIRO, DAISIE D. BOETTNER, MARGARET B. BAILEY, (2011), *Fundamentals of Engineering Thermodynamics*, John Wiley & Sons, USA.
4. RUDRAMOORTHY R., (2003), *Thermal Engineering*, Tata McGraw Hill, New York, USA.

	Basic Electrical Engineering	L	T	P	C	Hrs
		2	1	0	3	54

Objective: The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Unit - I: Introduction 6 Hrs

Ohms law - Kirchhoff's Laws - series and parallel circuits - source transformations - delta-wye conversion -linearity and superposition theorem with simple examples - The venin's and Norton's theorem with simple examples - maximum power transfer theorem with simple examples -Mesh analysis - nodal analysis - super node.

Unit - II: D.C Machines 6 Hrs

Basic principles of electrical machines - D.C. generators-construction details-principle of operation-emf equation-methods of excitation-simple problems - D.C. motors-principle of operation-back e.m.f.-speed and torque equations-characteristics-losses-efficiency-applications of shunt - series and compound wound motors-simple problems.

Unit - III: Poly phase circuits 12 Hrs

Generation of poly phase voltage-phase - difference-vector representation comparison between single phase and three phase systems-star and delta connection-current - voltage and power in three phase systems-balanced and unbalanced three phase circuits- power measurements in three phase circuits using single wattmeter and three wattmeter methods.

Unit - IV: AC Machines 9 Hrs

Alternators- principle of operation-types-emf equation (winding factor need not be derived)-synchronous speed-Synchronous motors-principle of operation and method of starting-three phase induction motors-construction details of squirrel cage and slip ring motors-slip speed-single

phase induction motors-principle of operation-types, Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Unit - V: Transformers 9 Hrs

Principle and theory of an ideal transformer - Constructional features of single phase transformer-core type-shell-type- emf equation- turns ratio-no load vector diagram-transformer on load- equivalent circuit- impedance transformation- transformer losses - efficiency- open circuit and short circuit tests-estimation of equivalent circuit parameters. Auto transformer – working principle - basics of current transformer - potential transformer and three phase transformer.

Unit - VI: Power generation & Distribution 12 Hrs

Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation; D.C. and A.C. transmission and distribution-two wire and three wire d.c. system - use of balancer - a.c. transmission single phase and three phase -three wire and four wire distribution - comparison of d.c. and a.c. transmission - effect of voltage drop - copper utilization under different systems - single and double fed distributors - fuses - d.c. air circuit breaker - a.c. air and oil circuit breakers - HV & LV switch gears

Text Books

1. B.L THERAJA, A.K. THERAJA, (2006), *A Text Book of Electrical Technology Volume –I and II*, S. Chand Publishers.
2. RAJENDRA PRASAD (2009), *Fundamentals of Electrical Engineering*, Prentice Hall, India

Reference Books

1. HUGHES EDWARD, (1995), *Electrical Technology*, Addison Weisley.

2. KULSHRESHTHA D.C. (2009), *Basic Electrical Engineering* , Tata McGraw Hill
3. VINCENT DEL TORO, (2001), *Basic electrical Engineering*, Second edition, Prentice Hall of India, 2nd Edition.

	Environmental Studies	L	T	P	C	Hrs
		2	0	0	2	36

Objective: To familiarize the students with the environmental issues associated with development

Unit I: Introduction and Natural Resources 6 Hrs

Multidisciplinary nature and public awareness - Renewable and nonrenewal resources and associated problems - Forest resources - Water resources - Mineral resources - Food resources - Energy resources - Land resources - Conservation of natural resources and human role.

Unit II: Ecosystems 6 Hrs

Concept - Structure and function - Producers composers and decomposers - Energy flow - Ecological succession - Food chains webs and ecological pyramids - Characteristics structures and functions of ecosystems such as Forest - Grassland - Desert - Aquatic ecosystems.

Unit III: Biodiversity and Conservation 8 Hrs

Definition - Genetic - Species - and Ecosystem diversity - Bio-geographical classification of India - Value of biodiversity at global - national - local levels - India as a mega diversity nation - Hot spots of biodiversity - Threats to biodiversity - Endangered and endemic species of India - In-situ and ex-situ conservation of biodiversity.

Unit IV: Environmental Pollution 8 Hrs

Definition - Causes - effects and control of air pollution - water pollution - soil pollution - marine pollution - noise pollution - thermal pollution - nuclear hazards - human role in prevention of pollution - Solid waste management - Disaster management - floods - earthquake - cyclone and landslides.

Unit V: Social issues and Environment 8 Hrs

Unsustainable to sustainable development - Urban problems related to energy - Water conservation and watershed management - Resettlement and rehabilitation - Ethics - Climate change - Global warming - Acid rain - Ozone layer depletion - Nuclear accidents - holocaust - Waste land reclamation - Consumerism and waste products - Environment protection act - Wildlife protection act - Forest conservation act - Environmental issues in legislation - population explosion and family welfare program - Environment and human health - HIV - Women and child welfare - Role of information technology in environment and human health.

Text Books:

1. BHARUCHA ERACH, (2004), *Textbook for Environmental Studies, University Grants Commission.*
2. AGARWAL K.C., (2001), *Environmental Biology*, Nidi Publication Ltd**.**, Bikaner.
3. BHARUCHA ERACH, (2002), *Biodiversity of India*, Mapin Publishing Pvt. Ltd., Ahmadabad.

Reference Books:

1. CLARK R.B. (2002), *Marine Pollution*, Clanderson Press, Oxford.
2. CUNNINGHAM W.P. et al, (2003), *Environmental Encyclopaedia*, Jaico Publishing House, Mumbai.

	Workshop Practice-I	L	T	P	C	Hrs
		1	0	2	2	54

To impart hands-on practice on basic engineering trades and skills.

Carpentry

1. Half-Lap Joint
2. Dovetail Joint
3. Corner Dovetail Joint
4. Central Bridal joint

Fitting

1. Square T-Fitting
2. Vee - Fitting
3. L- Fitting
4. Half Dovetail Fitting

Tin Smithy

1. Straight Tray
2. Cylinder
3. Conical Funnel
4. 90^0 Round elbow pipe

Foundry

1. Mold for a rectangle block
2. Mold for two-piece pattern

	Basic Electrical Engineering Lab	L	T	P	C	Hrs
		0	0	2	1	36

Electrical Engineering:

1. To measure the armature and field resistance of a DC machine.
2. To calibrate a test (moving iron) ammeter and a (dynamometer) Wattmeter with respect standard (DC PMMC) ammeter and voltmeters.
3. Verification of circuit theorems, Thevenin's and superposition theorems (with DC sources only).
4. Measurement of current, voltage and power in R-L-C series circuit exited by single-phase AC supply.
5. Open circuit and short circuit tests on a single-phase transformer.
6. Connection and starting of a three-phase induction motor using direct on line (DOL) or star delta starter.
7. Connection and measurement of power consumption of a fluorescent lamp and voltage current characteristics of incandescent lamps.
8. Determination of open circuit characteristics (OCC) or a DC generator.
9. Two-wattmeter method of measuring power in three-phase circuit (resistive load only).

	Computer Aided Drafting & Modelling	L	T	P	C	Hrs
		0	0	2	1	36

Objective: To enable the students to prepare 2D Drawings and 3D Models using a computer aided drafting and design software package.

Unit - I: Introduction 2 Hrs

History and overview: System requirements. Understanding the interface. Main Menu – Organization, screen menu, pull down menu, toolbars and graphic screen and command prompt area. Setting up new drawings – setting units, style, determining the scale factor, setting up drawing limits, setting up grid, snap modes. Undo and redo actions. Redrawing and generating, screen display. Moving around the drawing – Scrolling, Zooming features and pan mode. Object snap features – Entity selection features and Options for drafting setting.

Unit - II: Drawing features, 2 Hrs

Basic commands of drawing. Drawing of objects – Points, line, circle, arc, ellipse, polygon, rectangle, multiline. Drawing with precision. Drawing construction lines and rays. Modification of drawing with commands – copy, offset, array, move, erase, stretch, rotate, align, scale, extend, trim, break, chamfer, fillet, mirror and explode.

Unit - III: Display, Text and other Special Features 2 Hrs

Using name views, using tiled view ports. Creating text, creating text style, formatting text, changing text and scaling of text as per drawing scale. Poly lines – Drawing of polylines, editing polylines. Hatching areas – Creating and associative hatch, defining hatch boundaries, using hatch style, using hatch pattern, scaling of hatch pattern and editing of hatches. Splines – drawing of spline curves, editing splines. Creating regions and boundaries.

Unit - IV: Object properties, Commands & Dimensions 2 Hrs

Object properties: Layers, colour, line types, line type scale, line- weight. Enquiry commands: Calculating areas, calculating distance, use of measure and divide. Properties of 3-D object. Dimension types – Linear dimensions, radial dimensions, angular dimensions, aligned dimensions and leaders. Editing dimensions. Creating dimension styles. Dimension scale. Dimensional units and insertion of alternate units. Controlling of dimension variables.

Unit - V: Blocks definition, layout and plotting 2 Hrs

Block features - defining of blocks, block, W-blocks. Inserting block, reference edit of block, exploding of block and redefining of block. Using paper space and model space. Print settings, properties, paper layout, print scale and plotting.

Unit - VI: Isometric & 3-D features 2 Hrs

Isometric drawing concepts. Specifying 3-D co-ordinates, using UCS, viewing in 3-D, commands to generate 3-D Solids. Creation of 3-D models of simple objects and obtaining 2-D multi view drawings from 3-D model. Shading of 3-D objects. Creating rendering images. Extraction of image format files from 3-D solids.

Assignment / Practical's:- 24 Hrs

The practical will capture the different features of CAD listed the in the course content.

Text Books

3. GEORGE OMURA, BRIAN .C. BENTON (2017), *Mastering AUTOCAD*, Wiley (ISBN: 978-1-119-24005-1)
4. BHATT N D AND V M PANCHAL (2016) *Engineering Drawing*, Charotar Publishers.

Reference Books

1. MCCONNELL, J. J. *Computer graphics theory into practice,* Jones and Bartlett Publishers.
2. DAVIS, M. J. *Computer Graphics,* Nova Science Pub Inc.

	Computer Programing & Simulation Lab	L	T	P	C	Hrs
		0	0	2	1	36

Objective: To introduce the student on basics of computing, programming & simulation language

(Experiments may be carried out using software's like C language, MATLAB, Python, Scilab, etc.).

UNIT-I: Practical using Programming language 4 Hrs

Programs using nested for loops, functions with Pass by value, functions with Pass by reference, recursive functions.

UNIT-II Practical using Programming language 8 Hrs

Programs using one dimensional Array, two dimensional Arrays, Pointers and functions, Pointers and Arrays.

UNIT –III Practical using Simulation software 8 Hrs

Creating a One-Dimensional Array (Row / Column Vector) Exercise – Creating a vector of even whole numbers; Creating a Two-Dimensional Array (Matrix of given size) and performing Arithmetic Operations - Addition, Subtraction, Multiplication and Exponentiation. Obtaining Modified Matrix - Inverse, Transpose, with Appended and Deleted Elements.

UNIT–IV Practical using Simulation software 12 Hrs

Generating a Sinusoidal Signal of a given frequency (say, 100Hz) and Plotting with Graphical Enhancements - Titling, Labelling, Adding Text, Adding Legends, Adding New Plots to Existing Plot, Printing Text in Greek Letters, Plotting as Multiple and Sub-Plots; Also, Making

Non-Choppy and Smooth Plot of the functions, like

$f(x) = \sin(1/x)$ for $0.01 < x < 0.1$ and $g(x) = (\sin x) / x$.

Curve fitting techniques-linear and nonlinear regression, interpolation, smoothing and fit post processing.

UNIT–V Practical using Simulation software 4 Hrs

Introducing to filter-design analysis, signal analysis, Graphical User Interface layout editor.

Text Books

3. RAJARAMAN V & ADABALA N, (2014), *Computer Fundamentals*, Prentice Hall India Learning Pvt. Ltd.
4. KERNIGHAN.B.W & DENNIS RITCHIE, (2015), *The C Programming Language*, Second Edition, Pearson Education India.
5. RAJ KUMAR BANSAL, ASHOK KUMAR GOEL, MANOJ KUMAR SHARMA, 2012, *MATLAB & its applications in Engineering*, Pearson Publication

Reference Books

6. BYRON GOTTFRIED, (2010), *Programming with C*, Third Edition, Tata McGraw Hill Education.
7. R.G.DROMEY, (2001), *How to Solve it by Computers*, Prentice-Hall.
8. J.R. HANLY & E.B. KOFFMANN, (2009), *Problem Solving and Program Design in C*, Sixth Edition, Pearson Education.
9. PAUL DEITAL & HARVEY DEITAL, (2012), *C How to Program*, Seventh Edition, Prentice-Hall.
10. YASHAVANT KANETKAR, (2012), *Let Us C*, twelfth Edition, BPB Publications.

SEMESTER 3

(Regular Entry)

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Strength of Materials	ES	3	2	1	0	3
T	Fluid Mechanics -I	ES	3	2	1	0	3
T	Engineering Mathematics-III	BS	3	2	1	0	3
T	Marine Materials	PC	3	3	0	0	3
T	Introduction to Naval Architecture and Ocean Engineering	PC	3	3	0	0	3
P	Workshop Practice II	ES	2	0	0	4	4
P	Fluid Mechanics Lab	ES	1	0	0	2	2
P	Material Testing Lab	ES	1	0	0	2	2
P	Extra Academic Activity 3	MC	0	0	0	4	4
			19				27

(Lateral Entry)

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Strength of Materials	ES	3	2	1	0	3
T	Fluid Mechanics -I	ES	3	2	1	0	3
T	Mathematics Bridge Course*	BS	3	2	1	0	3
T	Engineering Mathematics-III	BS	3	2	1	0	3
T	Marine Materials	PC	3	3	0	0	3
T	Introduction to Naval Architecture and Ocean Engineering	PC	3	3	0	0	3
T	Computer Programming**	ES	3	3	0	0	3
P	Fluid Mechanics Lab	ES	1	0	0	2	2
P	Material Testing Lab	ES	1	0	0	2	2
P	Extra Academic Activity 3	MC	0	0	0	4	4
			23				29

* The Bridge Course combines the Mathematics courses offered in 1st & 2nd Semesters.

** The Computer Programming Course is same as that is offered in Semester 1 of the regular scheme.

	Strength of Materials	L	T	P	C	hrs
		2	1	0	3	54

***Objective: To understand the fundamentals of how materials behave under action of forces like tension, compression, shear, bending, and torsion*.**

Unit-I: Stresses and Strains 11 hrs

Concept of Stress and Strain - relationship in deformable solids - Normal, shear and hydrostatic stresses – strains - Poisson's Ratio --elastic constants - Uni-axial loading - Thermal Stress - Compound Stress and Strain - Principal plane & principal stresses - principal strains. Mohr's Diagrams –

Unit – II Shear and Torsion 11 Hrs

Combined bending and Twisting, Equivalent bending moment and Torsion, shear, bending and torsion, Theories of failure. Strain energy in Simple Stresses: Strain Energy - due to normal, Shear and Impact loads. - Resilience. Torsion - Twisting of solid and hollow shafts, Stiffness and Strength. Power and Torque relation. Torsion applied to closed coil springs, springs with axial load, Calculations for mean diameter of springs, wire diameter & number of coils. Strain Energy in torsion.

Unit-III: Bending Stress 9 Hrs

Shearing Force and Bending Moment - Sign Convention, Relation between Intensity of Loading, Graphical construction of Bending Moment & Shear Force diagrams - Bending Stress - Pure Bending - 2^{nd} moment of area- Stresses due to bending -

Unit-IV: Beams 11 hrs

Strain energy due to bending. Application of impact. Deflection by integration, Macaulay's Method. Moment area Methods of deflection coefficient. Deflection due to shear, Deflection by graphical method. Applied problems. Built-in and continuous beams - Moment-area method, built-in

beam with central concentrated load, built-in beam with uniformly distributed load, with load not at centre, Macaulay's method, Continuous beam, Claperyron's three moment theorem. Applied problems.

Unit-V: Shells and Columns 12 Hrs

Thin Walled Shells: Shells subjected to internal pressure; submersibles. Strengthening of Thin Walled Shells. Effect of temperature; volumetric strain on capacity. Thin Curved bar - Strain energy due to bending Castigliano's theorem, and its application to curved bars, strain energy due to twisting. Applied problems. Thick Cylinders - Lame's theory, compound cylinders, solid shaft subjected to radial pressure, shrinkage allowance. Applied problems. Columns theory - Euler's theory and Euler's buckling load. Columns with different end conditions - eccentric load, Rankine-Gordon Formula.

Text Books

1. PRAKASH RAO, D.S. (2004), *Strength of Materials A Practical Approach Volume – I,* Universities Press
2. RATTAN, S.S. (2011), *Strength of Materials*, Tata Mc Graw Hill

Reference Books

1. BHAVIKATTI, S.S. (2013) , *Strength of Materials*, Vikas Publishing house
2. BANSAL R.K. (2010), *Strength of Materials*, Laxmi Publications.
3. JOHN CASE, LORD CHILVER, CARL T.F. ROSS (2003), *Strength of Materials and structures*, Butterworth Heinemann.
4. MOTT R.L. (2015), *Applied Strength of Materials*, CRC Press.

	Fluid Mechanics-I	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To understand the fundamentals of fluid properties, flow kinematics, conservation laws and applications of fluid fundamentals to practical aspects like pipe flow, fluid machines.

Unit-I: Basics of flow **18 Hrs**

Properties of fluids - pressure measurement and manometers - hydrostatic forces on surfaces - buoyancy and floatation - liquids in relative equilibrium. Classification of flows - fluid kinematics - continuity equation - acceleration of a fluid particle - rotational and irrotational flow - circulation and vorticity - velocity potential - stream function.

Equations of motion and energy equation - Euler's equation of motion - conservation of energy - Bernoulli's equation - applications – venturimeter - pitot tube - other flow measurement devices - vortex motion - free liquid jet. Impulse momentum equations - force on a pipe bend - jet propulsion - momentum theory of propellers - moment of momentum equation.

Dimensional Analysis and Modelling Similitude - Fundamental and derived dimensions - Rayleigh method - Buckingham theorem - formation of dimensionless groups – similarity laws.

Unit-II: Flow through pipes **12 Hrs**

Types of flow – Reynold's experiment - laws of fluid friction - Froude's experiments - Darcy-Weisbach equation and other formulae for head loss in pipes due to friction - other energy losses in pipes - pipes in series and parallel - equivalent pipe - concept of siphon - concept of water hammer in pipes.

Unit-III: Impact of Jets & Turbines **9 Hrs**

Hydrodynamic force of jets on stationary and moving plates – flat - inclined and curved vanes - jet striking centrally and at tip - velocity triangles - inlet and outlet - expressions for work done and efficiency;

Hydraulic Turbines - Classification of hydraulic turbines - impulse and reaction turbines –working and application - Pelton wheel - reaction turbines - inward radial flow - Francis turbine - axial flow reaction turbine - Kaplan turbine. Performance of Turbines - Specific Speed, unit quantities - unit speed - unit discharge and unit power - performance and characteristic curves of hydraulic turbines - main - operating and constant efficiency curves.

Unit-IV: Pumps **9 Hrs**

Rotodynamic Pumps - Classification – mixed – axial – principle and application. Centrifugal Pumps - Main parts - work done by the impeller and head of the pump – efficiency – minimum speed for starting - specific speed of a centrifugal pump - priming of a centrifugal pump. Performance of pumps - Characteristic curves - concept of Net Positive Suction Head (NPSH) - cavitation. Positive Displacement Pumps - Fundamentals principle of positive displacement pumps –reciprocating type - advantages and disadvantages.

Unit-V: Hydraulic Devices **6 Hrs**

Hydraulic press - hydraulic accumulator - differential hydraulic accumulator - hydraulic intensifier - hydraulic ram - hydraulic lift - hydraulic crane - fluid coupling - hydraulic torque converter.

Text Books

1. MODI P.N. & SETH S.M. (2007), *A Text Book of Fluid Mechanics and Hydraulic Machines*, Standard Book House New Delhi.
2. MOHANTY A.K., (1994), *Fluid Mechanics*, Prentice Hall of India.

3. SUBRAMANYA, K. (2010), *Fluid Mechanics & Hydraulic Machines Problems and Solutions*, Tata Mc-Graw Hill Publishers.

Reference Books

1. RAJPUT R.K., (1998), *A Text Book of fluid Mechanics and Hydraulic Machines*, S. Chand & Co., New Delhi.
2. SOM S.R., & BISWAS, (1998), *Introduction to fluid Mechanics and fluid Machines*, Tata Mc Graw Hill Publishers.
3. BANSAL R.K., (2005), *Fluid Mechanics and Hydraulic Machines*, Laxmi Publications, New Delhi.
4. WHITE FRANK M., (2011), *Fluid Mechanics*, Tata Mc Graw Hill.

	Engineering Mathematics -III	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To provide basic concepts of statistical methods and procedures for solving problems occurring in engineering and technology.

Unit - I: Probability 6 Hrs

Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes Theorem and independence.

Unit – II: Random Variables 9 Hrs

Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, moment generating function, Chebyshev's Inequality-

Unit - III: Distributions 12 Hrs

Special Distributions - Discrete uniform, binomial, geometric, Poisson, exponential, gamma, normal distributions, function of a random variable.

Joint Distributions - Joint, marginal and conditional distributions, product moments, independence of random variables, bi-variate normal distribution.

Unit – IV: Sampling Distributions 12 Hrs

The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and f distributions. Estimation: The method of moments and the method of maximum likelihood estimation, confidence intervals for the mean(s) and variance (s) of normal populations.

Testing of Hypothesis - Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Newman - Pearson Fundamental Lemma, tests for one sample problems for normal populations

Unit – V: Curve Fitting, Regression and Correlation 15 Hrs

Curve fitting, the method of least squares, the least squares line, least, square line in terms of Sample variance and covariance, regression lines, regression coefficients, the least square parabola, multiple regression, standard error of estimate, linear correlation coefficient, Probabilistic interpretations of regression and correlation, interpretations of regression and correlation

Text Books

1. BALI N.P. & MANISH GOYAL, (2011), *A Text Book of Engineering Mathematics*, Eighth Edition, Laxmi Publications Pvt. Ltd.
2. ERWIN KREYSZIG, (2010), *Advanced Engineering Mathematics*, Tenth Edition, Wiley International.

Reference Books

1. JAY L. DEVORE, (2010), *Probability & statistics for Engineering & Scientist*, Eighth Edition, Cengage Learning.
2. WAL POLE H. MYERS & L. MYERS, (2010), *Probability and Statistics for Engineering & Scientists*, Ninth Edition, Pearson Education.
3. R.K. JAIN & SRK IYENGAR, (2007), *Advanced Engineering Mathematics*, Third Edition, Narosa Publications.
4. GREWAL B.S, (2011), *Higher Engineering Mathematics*, Khanna Publications.

	Marine Materials	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To provide the students with knowledge on different materials and their uses in marine industry including material selection, treatment techniques, corrosion control and Composites.

Unit –I: Crystal Structure 9 Hrs

Atomic structure- Atomic bonding in solids, Unit cells and Space lattices, Crystal structures, Concept of amorphous, single and polycrystalline structures, Miller Indices, Crystal Defects, point, line, surface and volume defects.

Unit –II: Polymers and Composites 9 Hrs

Introduction – Classification of Polymers – Types of Polymerization – Preparation - Properties and uses of some important polymers –Fabrication of plastics – Rubber – Synthetic rubbers –Composites, Difference between thermoplasts and thermosets. Types of resins, glass and carbon fibres, different types of fabrics and mats such as Chopped Stranded Mats (CSM), Woven Roving (WR) their properties - FRP, GRP materials. Different types of Moulding techniques - Lay-up techniques, and manufacturing requirements - Advantages and Disadvantages of Composites over Steel and Aluminium in shipbuilding.

Unit–III: Solid solutions & Phase Diagrams 9 Hrs

Types of Solid solutions – Hume-Rothery ratio – Intermediate phases –Solid solution alloys - Phase Diagrams- Introduction –Cooling curves –Gibbs Phase rule – Classification of equilibrium diagrams - Eutectic – Peritectic reactions – Equilibrium diagram for common non–ferrous alloys and ferrous alloys – Micro constituents of iron - Iron–Carbon equilibrium diagram, TTT diagram.

Unit - IV: Heat Treatment **9 Hrs**

Definition – Purpose of heat treatment - effect of thermal cycles on their micro-structure Heat treatment techniques - Annealing – Normalizing – Hardening -Tempering- Mar-tempering - Aus-tempering etc., Case Hardening and Surface Treatment - Carburizing - Cyaniding – Nitriding, Flame Hardening etc.

Unit - V: Testing of Materials, Corrosion and its control **9 Hrs**

Material properties such as toughness, hardness, Tensile strength, Yield Strength - Brittle Vs. Ductile Fracture - Creep and Fatigue - Tensile tests-standard test specimens - Impact test-Izod test, Charpy V-Notch test. Hardness Tests-BHN, VHN - Different types of non-destructive testing for materials - sizes and dimensions of test specimens for the above tests.

Corrosion - Introduction – Cause of corrosion – Theories of Corrosion – Differential aeration corrosion - Factors influencing corrosion –Types of corrosion – Corrosion control - Cathodic Protection, ICCP, MGPS systems.

Unit - VI: Materials in marine industry **9 Hrs**

Introduction to different types of materials used in shipbuilding- Material fabrication and service requirement - Classification society requirement - Selection of material for marine construction - Types of shipbuilding quality steels - Mild steels, normal strength steels (A, B, D, E classes)- High Tensile Steels (HTS) grades, High Strength Low Alloy (HSLA), Aluminium alloys - alloy designation - welding requirements - Strength of aluminium compared to steel - Composition of aluminium alloys used in ship building - Advantages of using aluminium over steel in ship building.

Text Books

1. RAGHAVAN V, (2015), *Material Science and Engineering A first course,* Prentice Hall of India.

2. ROBERT L. REUBEN, (1994), *Materials in Marine Technology*, Springer-Verlag.

References Books

1. WILLIAM D CALLISTER & DAVID G RETHWEISCH, (2013), Materials science and Engineering An Introduction, John Wiley and Sons
2. NARULA G.K., NARULA K.S., & Gupta V.K., (2007), *Material science*, Tata Mc Graw Hill.
3. SHENOI AND J.F. WELLICOME, (1993), *Composite Materials in Maritime Structures: Volume 1 Fundamental Aspects*, Cambridge University Press.
4. RAJENDRAN.V, (2011), *Material Science*, Tata Mc Graw Hill.

	Introduction to Naval Architecture and Ocean Engineering	L	T	P	C	hrs
		3	0	0	3	54

Objective: To provide basics of ocean environment, structures and ship building.

Unit – I: Introduction to Ocean Environment 9 Hrs

Resources - Oil and gas - mineral nodules – energy - food source etc., Ocean Environment - waves - tides and currents. Introduction to Naval Architecture - the art and science. Brief history of shipbuilding.

Unit -II: Evolution of ships and Shipbuilding materials 12 Hrs

General-purpose vessels to specialized vessels; Category of ships according to nature of cargo - defense and surveillance, engineering activities. Transportation passengers- pleasure crafts- service crafts- Categories according to type of support - Hydrostatic - Hydrodynamic, aerostatic - Aerodynamic.

Materials for construction – Wood – steel – Aluminum - Composites. Transition from Riveting to welding. Progress in propulsion systems – prime movers and propulsors – turbines - IC engines - Marine screw propellers - water jets – Voith Schneider Propeller - SRP.

Unit - III: Form and Geometry 9 Hrs

The hull of ship - streamlining of hull forms. Main particulars – displacement - form coefficients - tonnage. Layout and representation in different views - weights & CG - volume & capacities. Laws of flotation and stability. Strength of the hull girder and systems of framing - functions of the shell - decks – shear and camber - bulk heads and hatches. Dynamic effects such as slamming – pounding – panting - racking and shipping green water.

Unit –IV: Terminology of various parts 12 Hrs

Parts of the hull, interior parts, superstructure, deck house, cargo gear and deck machinery. Outfits and their purpose - anchor, rudder, propeller, bollard, windlass and other deck fittings- Life saving appliances- boats rafts and lifebuoy Fire fighting appliances - fire pump - fire main, extinguishers etc. Navigational and communication equipment's. Lights, shapes and sound signals.

Unit –V: Practical applications in ocean engineering 12 Hrs

Introduction to offshore structures-gravity platforms- jacket platforms - tension leg platforms- marine risers- submersibles- offshore pipelines Instrumentation for ocean applications - pressure sensors - current meters CTD -depth sounder - buoy systems - mooring systems etc.

Text Books

1. TUPPER E.C., (2013), *Introduction to Naval Architecture*, Elsevier Publishers.
2. Graff W. J., (1981), Introduction to Offshore Structures, Gulf Publishing Company.

Reference Books

1. LARIC D. FERREIRO, (2007), Ships *and Science,* MIT Press Cambridge.
2. THOMAS C. GILLMER, BRUCE JOHNSON, (1982), *Introduction to Naval Architecture*, Naval Institute Press, US.
3. ROBERT B. ZUBALY, (1996), *Applied Naval Architecture*, Schiffer Publishing.
4. SHIELDS, M. J., (1992), Offshore Structures, Vol. I, Springer-Verlag.

	Workshop Practice-II	L	T	P	C	hrs
		0	0	4	2	72

To impart hands-on practice on basic engineering trades and skills.

Welding

1. Lap Joint
2. Butt Joint
3. Corner Joint

Machining

1. Lathe- Taper turning
2. Lathe – Knurling
3. Lathe – Threading
4. Milling
5. Drilling
6. Shaping

Gas Cutting

1. Oxyacetylene Cutting

	Fluid Mechanics Lab	L	T	P	C	Hrs
		0	0	2	1	36

FLUID MECHANICS LABORATORY EXPERIMENTS

1. Calibration of Venturimeter
2. Calibration of orifices
3. Calibration of notches
4. Resistance characteristics of pipes – friction factor
5. Impact of a jet on a circular disc
6. Performance characteristics of centrifugal pump
7. Performance characteristics of reciprocating pump
8. Performance characteristics of Pelton Wheel turbine
9. To determine GM (metacentric height) of a floating body

	Material Testing Lab	L	T	P	C	Hrs
		0	0	2	1	36

1. To study the stress strain characteristics (tension & compression) of metals by using UTM.
2. Determination of compressive strength of wood
3. Determination of hardness using different hardness testing machines- Brinell's, Vicker's, and Rockwell's scales.
4. Impact Test by using Izod and Charpy Methods.
5. Deflection test on beams using UTM.
6. Direct shear test on MS rods.
7. To find stiffness and modulus of rigidity of steel by conducting compression test on springs.
8. Torsion test on circular shafts.
9. Fatigue test on mild steel specimen

	Mathematics Bridge Course	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To acquaint the Lateral Entry students with Mathematical tools needed in engineering fields.

Unit - I: Mean Value Theorem 6 Hrs

Rolle's Theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders. Indeterminate forms - Concavity and convexity of a curve, points of inflexion - asymptotes and curvature.

Unit - II: Differential calculus of several variables 6 Hrs

First order differential equations - exact linear and Bernoulli's form - Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

Unit – III: Analytic Functions & Complex Integration 6 Hrs

Functions of a complex variable – Analytic functions Necessary conditions– Cauchy-Riemann equations and sufficient conditions (excluding proofs)– Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: w = z+k, kz, 1/z, z2, eZ and bilinear transformation, Complex integration – Statement and applications of Cauchy's integral

Theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue Theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

Unit – IV: Multiple Integrals 6 Hrs

Double integrals in Cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves. Change of variables in double integrals – Area of a curved surface – Triple integrals – Volume of Solids.

Unit – V: Matrices 6 Hrs

Eigen values and Eigen vectors of a real matrix – Characteristic equation– Properties of Eigen values and Eigen vectors – Statement and applications of Cayley - Hamilton Theorem – Diagonalization of matrices.

Unit - VI: Vector Calculus **6 Hrs**

Gradient - divergence and curl–Directional derivative – Irrational and solenoid vector fields – Vector integration – Green's theorem in a plane - Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.

Unit - VII: Laplace Transform **6 Hrs**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions – Derivatives and integrals of transforms – Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform.

Unit - VIII: Partial Differential Equations **6 Hrs**

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations - Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both Homogeneous and non - homogeneous types and Applications

Unit - IX: Fourier Transforms **6 Hrs**

Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Text Books

1. BALI N. P & MANISH GOYAL, (2011), *A Textbook of Engineering Mathematics*, Laxmi Publications Pvt Ltd, New Delhi.

2. GREWAL B.S, (2011), *Higher Engineering Mathematics*, Khanna Publications, New Delhi.

Reference Books

1. SIVARAMA KRISHNA DAS P. & RUKMANGADACHARI E., (2011) *Engineering Mathematics Volume II*, PEARSON Publishing, London, UK.

2. PETER V. O'NEIL, (2012), *Advanced Engineering Mathematics, 7th Edition*, Cengage learning, Boston, USA.

3. GLYN JAMES, (2012), *Advanced Modern Engineering Mathematics, 3rd Edition*, Pearson Education, London, UK.

4. ERWIN KREYSZIG, (2010), *Advanced Engineering Mathematics*, Wiley International, New Jersey

SEMESTER 4

Regular Entry

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Fluid Mechanics -II	PC	3	2	1	0	3
T	Hydrostatics & Stability	PC	4	3	1	0	4
T	Engineering Mathematics-IV	BS	3	2	1	0	3
T	Physical Oceanography	PC	3	3	0	0	3
T	Ship Construction / Ship structural arrangements	PC	3	3	0	0	3
T	Basic Structural Analysis	ES	3	2	1	0	3
P	Technical English, Communication & Soft Skills	HS	2	1	0	2	3
P	Hydrostatics & Stability Lab	PC	2	0	0	4	4
P	Extra Academic Activity 4	MC	0	0	0	3	3
			23				29

Lateral Entry

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. Of Hrs /week
T	Fluid Mechanics –II	PC	3	2	1	0	3
T	Hydrostatics & Stability	PC	4	3	1	0	4
T	Engineering Mathematics-IV	BS	3	2	1	0	3
T	Physical Oceanography	PC	3	3	0	0	3
T	Ship Construction / Ship structural arrangements	PC	3	3	0	0	3
T	Basic Structural Analysis	ES	3	2	1	0	3
P	Computer Programming & Simulation Laboratory***	ES	1	0	0	2	2
P	Technical English, Communication & Soft Skills	HS	2	1	0	2	3
P	Hydrostatics & Stability Lab	PC	2	0	0	4	4
P	Extra Academic Activity 4	MC	0	0	0	3	3
			24				31

*** The Computer Programming & Simulation Laboratory Course is same as that is offered in Semester 2 of the regular scheme

	Fluid Mechanics -II	L	T	P	C	Hrs
		2	1	0	3	54

Objective:

- ***To understand fluids under dynamic conditions and effects of viscosity***
- ***To understand the boundary layer effect***

Unit – I: Kinematics of fluid flow 14 Hrs

Introduction **-** Types of fluid flow **-** continuity equation - Velocity and acceleration - potential and stream function - Types of motion - Vortex flow - Euler's equation of motion – Bernoulli's equation – practical application - Momentum equation – Problems.

Unit – II: Potential flow 7 Hrs

Ideal Flow-Introduction - Important cases of potential flow - uniform flow - source - sink - free- vortex - super imposed flow – source and sink pair - doublet - plane source in uniform flow - source and sink pair in uniform flow - doublet in uniform flow - steady translation of a cylinder in an infinite fluid medium- Magnus effect.

Unit - III: Viscous Flow 7 Hrs

Viscosity of fluids - Flow through a pipe of circular section - flow of fluid between parallel plates – Couette flow - Poiseuille flow - Navier-Stoke equation of motion

Unit – IV: Boundary Layer Theory 14 Hrs

Boundary Layer flow - Introduction - Definitions drag force on flat plate due to boundary layer - turbulent Boundary Layer on flat plate - total drag on flat plate due to laminar and turbulent layer - Separation of Boundary Layer - problems.

Unit – V: Flow around Submerged Bodies 12 Hrs

Introduction - Force Exerted by a flowing fluid on a stationary body - drag, lift forces – expression Drag on sphere – cylinder - Development of lift on circular cylinder, Aero foils - Lift – drag - circulation - pressure distribution - theory of thin air foils - wings of infinite and finite span - circulation distribution - Cavitation. Two dimensional aerofoils – Joukowski aerofoils

Text books

1. MODI P.N. & SETH S.M., (2007), *A text Book of fluid Mechanics and Hydraulic Machines*, Standard Book House, New Delhi.
2. SOM, S.R. & BISWAS, (1998), *Introduction to fluid mechanics and Hydraulic machines*, Tata McGraw Hill.
3. K.SUBRAMANYA, (2010), *Fluid Mechanics & Hydraulic Machines Problems and Solutions*, Tata McGraw Hill.

Reference books

1. BATCHELOR G.K., (2012), *An introduction to Fluid Dynamics*, Cambridge University Press, New Delhi.
2. BANSAL R.K., (2005), *Fluid Mechanics and Hydraulic Machines*, Laxmi Publications, New Delhi. Milne Thompson L. M. (1996) *Theoretical Hydrodynamics*, Dover Publications.
3. WHITE FRANK M., (2011), *Fluid Mechanics*, Tata McGraw Hill**.**
4. CHORLTON, F, (2004), *Text of Dynamics*, CBS Publications.

	Hydrostatics & Stability	L	T	P	C	Hrs
		3	1	0	4	72

Objective: To Understand the basic concepts of stability of ship

Unit – I: Introduction **12 Hrs**

Hull form definition of ships, Ship's Lines, Displacement and weight relationships, coefficients of form; State of equilibrium, Tonnage – Gross Tonnage & Net Tonnage.

Unit - II: Integration rules and Methods **15 Hrs**

Numerical integration formulae to obtain areas, volumes, moments and moment of inertia and buoyancy; Bonjean calculations and curves, wetted surface; hydrostatic calculations and curves.

Unit –III: Stability **18 Hrs**

Initial stability of floating and submerged body - stability at small angles of inclinations – Metacentre, Metacentric height; stability at large angles of inclinations - wall sided formula. Curve of static stability - angle of loll, cross curves of stability - effect of addition and removal of weights, internal shift of weights - suspended weights - free surface effect due to partial filling of tanks. Determination of GM - inclining experiment. Effect of change of Breadth, Depth and Form on stability.

Unit –IV: Dynamic Stability **12 Hrs**

Work done against wind heeling moment, heeling during turning, heeling during asymmetric towing; IMO stability criteria; Stability during dry docking and grounding; Launching calculations.

Unit–V: Damaged stability **15 Hrs**

Fundamental effects of damage, subdivision and damage stability calculations – margin line, floodable length & curves, permissible length,

factor of sub-division, criterion of service numeral, permeability - Probabilistic and deterministic damage stability - Survival requirements.

Text Books

1. JOHN LETCHER, (2009), *Principles of Naval Architecture series: The Geometry of Ships*, Society of Naval Architects and Marine Engineers.
2. COLIN S. MOORE, (2010), *Principles of Naval Architecture series: Intact Stability*, Society of Naval Architects and Marine Engineers.
3. RAWSON K J. and E.C. TUPPER, (2001), *Basic Ship theory Volume I*, Fifth Edition, Butterworth Heinmann.

Reference Books

1. ERIC TUPPER, (2013), *Introduction to Naval Architecture*, Fifth Edition, Butterworth Heinmann.
2. ADRAIN BIRAN RUBEN LPEZ PULIDO, (2013), *Ship Hydrostatics and stability*, Second edition, Butterworth Heinmann.
3. BELENKY V.L. and N.B. SEVASTIANOV, (2007), *Stability and safety of ships Risk of Capsizing*, Society of Naval Architects and Marine Engineers.

	Engineering Mathematics-IV	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To provide basic concepts of numerical methods and give procedures for solving complex engineering problems numerically.

Unit–I: Solution of Equations and Eigen Value 12 Hrs

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel –Matrix Inversion by Gauss Jordan method- Eigen values of a matrix by Power method.

Unit – II: Interpolation and Approximation 9 Hrs

Interpolation with unequal intervals -Lagrange's interpolation –Newton's divided difference interpolation – Cubic Splines – Interpolation with equal intervals -Newton's forward and backward difference formulae.

Unit-III: Numerical Differentiation and Integration 12 Hrs

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

Unit –IV: Initial value problems for Ordinary Differential Equations 9 Hrs

Single Step methods -Taylor's series method - Euler's method – Modified Euler's method - Fourth order Runge–Kutta method for solving first order equations – Multi step methods - Milne's and Adams – Bash forth predictor corrector methods for solving first order equations.

Unit – V: Boundary Value problems in ordinary and partial differential Equations 12 Hrs

Finite difference methods for solving two – point linear boundary value

problems –Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method

Text Books

1. ERWIN KREYSZIG, (2010), *Advanced Engineering Mathematics,* Wiley International.
2. GERALD C.F. & WHEATLEY P.O., (2006), *Applied Numerical Analysis, 6th Edition,* Pearson Education, New Delhi.

Reference Books

1. CHAPRA S.C. & CANALE R.P., (2007), *Numerical Methods for Engineers 5th Edition*, Tata McGraw Hill, New Delhi.
2. BRAIN BADIE, (2007), *A friendly Introduction to Numerical Analysis*, Pearson Education, New Delhi.
3. SANKARA RAO K., (2007), *Numerical Methods for Scientists and Engineers 3rd Edition,* Prentice hall of India Pvt Ltd, New Delhi.
4. GREWAL B.S. & GREWAL J.S., (2007), *Numerical Methods in Engineering Mathematics 9th Edition*, Khanna Publishers, New Delhi.

	Physical Oceanography	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To develop an understanding of ocean environment in terms of sea water, ocean currents, tides and physical setting

Unit – I: Physical properties of sea water 10 Hrs

Salinity and conductivity - Temperature - Density effects - Sound and light in the sea - Colour of sea water. Observational techniques-various methods in the collection of data.

Unit - II: Distribution of water characteristics 10 Hrs

Vertical and geographical distribution of temperature - salinity and Density, temperature, salinity and density profiles. Dissolved constituents – oxygen, Carbon-di-oxide. Seasonal variation of dissolved constituents – global warming and dissolved carbon – ocean acidification.

Unit – III: Ocean currents 12 Hrs

Wind induced surface currents - Geostrophic Current and Ekman Wind Drift Current - Ocean Current Estimation - Current measurements - thermocline circulation - Dynamic computation - General circulation of ocean waters – Westward intensification - Stommel and Munk's circulation models – regional current patterns around India.

Unit – IV: Tides and extreme events 10 Hrs

Tide producing forces - tidal theories – equilibrium and dynamic theory – oceanic propagation – deformation of tidal wave on propagation – Kelvin waves - amphidromic points - tidal bores - tidal currents – tidal observation - Harmonic analysis – prediction – factors influencing the prediction - Long term effects – Basin oscillations Tsunamis and storm surge.

Unit - V: Ocean dimensions and Geological aspects 12 Hrs

Ocean boundaries - Geomorphology and structure of the Ocean floor - continental slope and shelf. Marine sediments, their formation types, distribution and classification - Distribution of marine minerals along the Indian Coasts - Placer deposits hydrocarbon deposits and polymetallic nodules - Exploration and exploitation of natural minerals off the coast. Coastal Processes – littoral drift - sediment transport along shoreline – implications - coastal upwelling - estuaries – types- estuarine circulation - Problem session.

Text Books

1. ROBERT H. STEWART, (2008), *Introduction to Physical Oceanography*, Department of Oceanography Texas A & M University.
2. TOM GARRISON, (1998), *Oceanography: An Invitation to Marine Science*, Wadsworth Publishing, California, USA.

Reference Books

1. Mc CORMICK, J.M. & THIRUVATHUKAL J.V., (1976) Elements of Oceanography, W.B. Saunders Company, Philadelphia.
2. L.D. TALLEY G.L. PICKARD W.L. EMERY J.H. SWIFT 2011 Descriptive Physical Oceanography An Introduction. Elsevier Publishers
3. GEORGE L. MELLOR, (1996), *Introduction to Physical Oceanography*, Springer, New York
4. BRUCE A.WARREN CARL WUNSCH, (1980), *Evolution of Physical Oceanography*, MIT press.

	Ship Construction / Ship Structural Arrangements	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To impart the knowledge on shipbuilding materials, joining techniques, structural arrangement and outfitting of ships.

Unit –I: Shipbuilding materials and Joining techniques 9 Hrs

Ship building materials – transition from wood to steel, shipbuilding quality steels (properties, steel grades) – Riveting - Welding - Fusion welding methods – manual metal arc welding, gas metal arc welding, submerged arc welding, electro gas welding, electro slag welding, single side welding, multi electrode welding - Weld joints (butt joints, fillet joints, lap joints) - Welding symbols.

Unit – II: Ship structural systems 12 Hrs

Ship as stiffened plate structure – framing systems, common stiffener sections, corrugated construction, design of strakes (butts, seams), welding sequences, shell expansion - Structural subsystems – break up into bottom structure, side structure, deck structure, bulkhead structure, end structure, superstructure etc., general structural arrangements of different types of ships.

Unit –III: Bottom structure and Side structure 12 Hrs

Bottom structure – framing system, functions, single bottom and double bottom construction, structural components and scantlings, openings, cut outs, connection details, bilge keel - Side structure – framing system, functions, structural components - Decks and Bulkheads - Deck structure – functions, framing system, structural components, hatch ways, pillars - Bulkhead structure – type of bulkheads, functions, framing system, structural components.

Unit –IV: End structures **12 Hrs**

Fore end structure – functions, structural arrangements (panting), structural components - After end structure – functions, structural arrangements, structural components - Structural connections – compatibility, bottom & side, side & deck, bulkhead with deck, side & bottom - Chain locker and hawse pipe - Rudder construction.

Unit –V: Engine Room, Super structure, Outfitting **9 Hrs**

Engine room – functions, general arrangement, engine casing, foundations - Superstructure and Deckhouses – functions, structural arrangement, effectiveness of superstructure & deckhouse, expansion joints - Bulwarks - Outfitting **–** Hatch covers, closing appliances for openings on deck and exposed bulkheads, mooring equipment and arrangements, fenders, railings, deck fittings, masts, insulation and panelling.

Text Books

1. EYRES D.J., (2011), *Ship Construction*, William Heinemann Ltd, London.
2. N. R. MANDAL, (2017), *Ship Construction and Welding*, Springer.

Reference Books

1. YONG BAI, (2003), Marine Structural Design, Elsevier Science.
2. TAGGART, (1980), *Ship Design and Construction*, Society of Naval architects and Marine Engineers.
3. D A Taylor, 1992, Merchant Ship Construction, Institute of Marine Engineers.
4. RICHARD LEE STORCH, COLIN P. HAMMON, HOWARD MC, RAVEN BUNCH & RICHARD C. MOORE, (1995), *Ship Production*, Society of Naval Architects and Marine Engineers.

	Basic Structural Analysis	L	T	P	C	Hrs
		2	1	0	3	54

Objective: To introduce to the students the methods and processes required to carry out structural analysis

Unit – I: Introduction 12 Hrs

Review of basics of strength of materials topics of shear force and bending moment diagrams, evaluation of bending stress and shear stress in beam members, deflection of beams, Failure Theories, Fatigue and Fracture: Fatigue analysis – SN curve and Fatigue damage accumulation and calculation, Low cycle Fatigue and high cycle Fatigue. Fracture analysis – Linear Elastic Fracture Mechanics, crack propagation, Fracture toughness.

Unit – II: Continuous beams 9 Hrs

Analysis of continuous beam by method of forces, analysis by three moment equation method

Unit – III: Portal frame method 9 Hrs

Basic concept of portal frame method, analysis of frames as example problems

Unit – IV: Matrix methods 12 Hrs

Introduction to matrix method in structural analysis – Nodes, elements. Development of relevant matrices - stiffness matrix, load matrix, displacement matrix, assembly of global stiffness matrix. Example problems as applications in trusses and beams.

Unit – V: Numerical methods 12Hrs

Computer implementation of matrix method – General format of structural analysis, various numerical schemes for – solution of simultaneous equations, solution to Eigen value problems, dynamic analysis.

Text books

1. FLEMING JOHN F. (1989); *Computer Analysis of Structural Systems*, McGraw Hill International Edition.
2. REDDY, C.S. (2010); *Basic Structural Analysis*, Tata-McGraw Hill Publications.
3. BANSAL R.K. (2010), *Strength of Materials*, Laxmi Publications.

Reference books

1. MUKHOPADHYAYA M. (1993); *Matrix, Finite Element, Computer Structural Analysis*, Oxford & IBH Publishing Co.
2. TIMOSHENKO & YOUNG (1965); *Theory of Structures*, McGraw Hill Publications.
3. RUSSELL. C. HIBBELER (2014); *Structural analysis*. Ed. 9, Prentice Hall.

	Technical English, Communication and Soft Skills	L	T	P	C	Hrs
		1	0	2	2	54

Objective: To build proficiency in Technical writing, Oral Communications & Personality Development.

Unit-I: English for communication 18 hrs

Technical vocabulary, Synonyms and Antonyms, Numerical adjectives, Conjunction and Preposition clauses, Noun and adjective clauses, Abbreviations, Acronyms and homonyms, anagrams, Portmanteau words, Phrasal verbs and idioms. Relative clauses, Imperative and infinitive structures, Question pattern, Auxiliary verbs (Yes or No questions), Contrasted time structures, Adverbial clauses of time, place and manner, Intensifiers, Basic pattern of sentences. Issues of 21st century.

Unit - II: Information Design and Development 9 Hrs

Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media

Unit - III: Technical Writing and Editing 9 Hrs

Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Editing strategies to achieve appropriate technical style. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report, resumes.

Unit - IV: Oral Communication **9 Hrs**

Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Self-assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem.

Unit - V: Ethics **9 Hrs**

Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, Managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, Taking notes, Complex problem solving, Creativity.

Text Books

1. CHANDRALEKHA RAO et al., (2016), *Spring Part One*, Emerald Publishers, Chennai.
2. USHA SAIKUMAR et al., (2017), *Panorama*, Emerald Publishers, Chennai.
3. DAVID F. BEER AND DAVID MCMURREY, (2004), Guide to writing as an Engineer, John Willey. New York.
4. DIANE HACKER, (2003) *Pocket Style Manual*, Bedford Publication, New York, (ISBN 0312406843)
5. SHIV KHERA, (2003) *You Can Win*, Macmillan Books, New York.
6. RAMAN SHARMA, (2004) *Technical Communications*, Oxford Publication, London.

Reference Books

1. BHASKARAN NAIR et al., (2016), *Reflections*, Cambridge University, New Delhi.
2. DALE JUNGK, (2004) *Applied Writing for Technicians*, McGraw Hill, New York, (ISBN: 07828357-4)
3. SHARMA, R. AND MOHAN, K. (2002) *Business Correspondence and*

Report Writing, TMH New Delhi.

4. XEBEC, (2000) *Presentation Book*, TMH New Delhi, (ISBN 0402213)

	Hydrostatics and Stability Lab	L	T	P	C	Hrs
		0	0	4	2	72

The following drawings & calculation to be prepared by the students

1. Manually project three orthogonal 2D views and inter-match them by cross fairing (developing of lines plan) for a given offsets table.

2. Calculations and graphs of Hydrostatics, cross curves and Bonjeans

3. Calculations for a given loading condition

SEMESTER 5

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. of Hrs /week
T	Ship Structures	PC	3	3	0	0	3
T	Resistance & Propulsion	PC	4	3	1	0	4
T	Ship Production Technology	PC	3	3	0	0	3
T	Ocean Waves	PC	3	3	0	0	3
T	Basic Electronics Engineering	ES	3	3	0	0	3
P	Structural Design Lab	PC	2	0	0	4	4
P	Basic Electronics Laboratory	ES	1	0	0	2	2
P	Basic Design Software Lab	PC	2	0	0	4	4
	TOTAL		21				26

	Ship Structures	L	T	P	C	hrs
		3	0	0	3	54

Objective: To introduce basic principles of ship structures with specific focus on the theory associated with the structural members and the understanding the basics of theory of reliability.

Unit – I: Introduction & longitudinal bending: 14 Hrs

The forces acting on a ship at sea, Static forces, Dynamic forces, the distortion of the ship's structure, function of the ship's structure. Longitudinal bending: Assumed form of wave system, Hogging and sagging, The buoyancy curve, The weight curve Distribution of deadweight items, Modified form of weight curve, The load curve, Shearing force curve, Bending moment curve, Characteristics of shear force and bending moment curves, Influence of weight distribution on bending moment, Calculation of bending moment due to addition of weight, Approximations to bending moment and shearing force.

Unit – II: Stresses in ship structures 10 Hrs

Stresses in ship structure: Bending theory applied to ship's structure, Calculation of the section modulus, Stresses in the inclined condition, Calculation of the deflection of the structure, Calculation of shear stress in the structure, Concept of shear flow, Concept of effective breadth, Influence of shear stress on bending stress, Standard of longitudinal strength.

Unit – III: Plate theory – bending and buckling 14 Hrs

Theory of plates: Introduction, Bending of wide plates, Bending of panels of plating, Simply supported rectangular plate with uniformly distributed load, Rectangular plate bent by edge couples, Plates with clamped edges, Influence of membrane stresses on strength of plates, Plane stress theory.

Buckling of structures: Introduction, Buckling of a wide plate, buckling of a simply supported rectangular plate, Influence of longitudinal stiffeners on the buckling strength of plating, Combination of longitudinal and transverse stiffening, Influence of transverse stiffeners on buckling of plating, Influence of curvature on buckling strength of plating. Grillages: Simple grillage and multi-stiffener grillage, simply supported grillage.

Unit – IV: Composite construction, superstructures and plastic theory 9 Hrs

Composite construction: Introduction, Two materials with the same elastic modulus, two materials of different elastic moduli, the bending of a composite beam. Structural discontinuities and superstructures: Introduction, Structural discontinuities, Superstructure ends, Deck openings, Superstructure efficiency and factors affecting it. Plastic theory: Introduction, Stress-strain diagram, Calculation of plastic neutral axis and plastic moment, Ultimate strength of a simply supported beam, Ultimate strength of a fixed-ended beam, Application of plastic theory to ship structure, Ultimate longitudinal strength of ship.

Unit – V: Reliability & FSM 7 Hrs

Introduction to reliability theory - reliability framework in marine structures - concept of limit states - levels of reliability - methods of reliability estimates and limitations - reliability index - basic idea of FORM (First Order Reliability Method) and SORM (Second Order Reliability Method), Introduction to Formal Safety Assessment (FSM).

Text Books

1. WILLIAM MUCKLE, (1967), *Strength of Ship Structures*, Edward Arnold Publications.
2. YONG BAI, WEI LIANG JIN, (2016), *Marine Structural Design*, Elsevier Publishers.

Reference Books

1. OKUMOTO Y, TAKEDA Y, MANO M, OKADA T, (2009), *Design of Ship Hull structures-A practical Guide for Engineers,* Springer Publishers.
2. ALA MANSOUR, DONALD LIU, (2008), *Strength of Ships and Ocean Structures*, Society of Naval Architects & Marine Engineers Publication.
3. MOHAMMED SHAMA, (2010), *Torsion & Shear stresses in Ships*, Springer Publishers.
4. JEOM KEE PAIK, ANIL KUMAR, THAYAMBALLI, (2004), *Ultimate Limit State Design of Steel Plated Structures*, John Wiley & Sons Publishers.

	Resistance & Propulsion	L	T	P	C	Hrs
		3	1	0	4	72

Objective: Provide fundamental understanding of various ship resistance components, basics of ship propulsion and experimental methodologies

Unit – I: Ship resistance 18 Hrs

Dynamic similarity- Froude hypothesis - Viscous resistance - Laminar and turbulent flows - Effect of roughness - Friction line- Form resistance - Wave resistance - Kelvin wave pattern and waves generated by a ship - Wave interference - effect of bulbous bow - Air resistance - Appendage drag Ship resistance in shallow water - Resistance data presentation; Estimation of effective power - methodical series and statistical methods- Hull form and resistance - Ship model tests and resistance data presentations- comparison of resistance prediction with results of full-scale trials.

Unit - II: Propeller Theory & propeller hull Interaction 12 Hrs

Screw Propellers - Propeller Geometry - Propeller Blade Sections - Alternative Definition of Propeller Geometry – Pitch - Non-dimensional Geometric Parameters - Mass and Inertia. Axial Momentum Theory - Momentum Theory Including Rotation - Blade Element Theory - Circulation Theory. Propeller in Open Water **-** Laws of Similarity - Dimensional Analysis - Laws of Similarity in Practice - Open Water Characteristics - Methodical Series Data – Alternative Forms of Propeller Coefficient. Propeller behind the Ship – Wake - Thrust Deduction - Relative Rotative Efficiency - Power Transmission - Propulsive Efficiency and its Components - Estimation of Propulsive Factors

Unit – III: Cavitation & Strength of Propellers 9 Hrs

Phenomenon of Cavitation - Cavitation Number - Types of Propeller Cavitation - Effects of Cavitation - Prevention of Cavitation - Cavitation Criteria – Pressure distribution on a Blade section. Strength of Propellers -

Bending Moments due to Thrust and Torque - Bending Moment due to Centrifugal Force - Stresses in a Blade Section – Approximate Methods – classification society Requirements - Propeller Materials.

Unit – IV: Model Experiments & Ship Trials 18 Hrs

Resistance Experiments - Open Water Experiments - Self-propulsion Experiments - cavitation experiment. Propeller Design **-** Propeller Design Approaches - General Considerations in Propeller Design - Propeller Design Using Methodical Series Data – Design of towing duty propeller –engine propeller Matching- Ship Trials and Service Performance.

Unit - V: Unconventional Propulsion Devices 15 Hrs

Paddle Wheels - Controllable Pitch Propellers - Ducted Propeller - Contra-rotating Propellers- Tandem Propellers - Overlapping Propellers - Other Multiple Propeller Arrangements - Vane Wheel Propellers - Other Unconventional Screw Propellers - Cycloidal Propellers - Flow Improvement Devices.

Text books

1. LARS LARSSON and HOYTE C. RAVEN, (2010), *Principles of Naval Architecture Series: Ship Resistance and Flow*, Society of Naval Architects and Marine Engineers Publication.
2. JUSTIN E. KERWIN and JACQUES B. HADLER, (2010), *Principles of Naval Architecture Series: Propulsion*, Society of Naval Architects and Marine Engineers Publication.
3. GHOSE P. & GOKARN R.P., (2015), *Basic Ship Propulsion*, Knowledge World Publishers Pvt Ltd.

Reference Books

1. JOHN CARLTON, (2012), *Marine Propellers and Propulsion 3rd Edition*, Butterworth Heinemann.

2. SV.AA. HARVALD, (1983), *Resistance and Propulsion of ship*, Wiley Inter science Publications.

3. MOLLAND F., DOMINIC A. HUDSON & STEPHEN R. TURNOCK, (2011), *Ship resistance and Propulsion*, Cambridge University Press.

	Ship Production Technology	L	T	P	C	Hrs
		3	0	0	3	54

***Objective: To impart the knowledge of ship production i.e., fabrication of parts, assembly, erection of ship hull, launching and different technologies adopted in ship production*.**

Unit -I: Characteristics of Ship Building 9 Hrs

Characteristics of shipbuilding process as heavy and one off kind maritime industry - General principles on layout of shipyards - Relation with supply industry - Subcontractors - Storage and preparation of material, material handling - Transport system in steel stockyard - Material preparation (straightening of plates and rolled sections, shot blasting, pre painting) - Material preparation flow line devices and their control systems.

Unit – II: Fabrication of component parts 12 Hrs

Cutting process, tools, physical and chemical background of the cutting process, mechanical cutting, devices for thermal cutting - General description of the various machines - Photoelectric and NC control devices - Edge preparation - Problems of accuracy - Bending of rolled and built up sections, general description of bending, control of the bending process - Automation of bending - Plate bending, uniaxial bending, biaxial bending (devices, cold bending, heat line bending) - Possibilities of automated plate bending.

Unit –III: Assembly of Ship Structures 12 Hrs

Prefabrication – general remarks, basic problems of prefabrication, pattern of prefabrication - Welding in prefabrication - Data generation for ship building - Basic welding in shipbuilding, welding positions (1G, 2G, 3G etc.), standards, weld symbols – Subassemblies, built up T bars, web frames, machine foundations etc. - Welding deformation and straightening - Prefabrication of flat sections - Panels, panel production line, preassembly of biaxial stiffened panels, welding procedures - Assembly of flat and

corrugated sections - Flat sections with curvature, Assembly jigs - Preassembly of volume units – Preassembly of double bottom sections - Preassembly of side tank units - Preassembly of the fore and aft end structure - Preassembly and outfit of superstructure - Outfitting shops (Mechanical, Piping, Insulation).

Unit – IV: Erection of ship's hull 12 Hrs

General assembly methods - Handling of preassembled units in the erection area – Cranes, heavy duty truck - Preassembly of blocks – Hull assembly, different methods of hull assembly - Welding in ship's hull assembly, welding methods applied, welding defects, welding deformation of the ship's hull - Quality control (X-ray tests etc.) - Scaffolds. Activities in shipyard pipe, machine and shipwrights shops.

Unit – V: Launching 9 Hrs

General methods - Launching by floating off (dry dock, floating dock) - Mechanical launching methods – Ship lift - Launching from inclined building berths, stern launching, side launching, tipping, pivoting.

Text Books

1. THOMAS LAMB, (2003), *Ship Design and Construction-Volume I,* Society of Naval Architects and Marine Engineers.
2. RICHARD LEE STORCH, COLIN P. HAMMON, HOWARD MC, RAVEN BUNCH & RICHARD C. MOORE, (1995), *Ship Production*, Society of Naval Architects and Marine Engineers Publication.

References Books

1. ROBERT TAGGART, (1980), *Ship Design and Construction,* Society of Naval Architects and Marine Engineers Publication.
2. MANDAL. N. R., (2017), *Ship Construction and Welding*, Springer.
3. EYRES D. J., (2011), *Ship Construction*, William Heinemann Ltd, London.

	Ocean Waves	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To develop understanding about the basics of ocean waves and their effects on engineering structural elements.

Unit – I: Basics **6 Hrs**

Introduction; Types of flow - Continuity Equation and Conservation of Mass - Forces Acting on Fluids in Motion - Euler's Equation of Motion - Path lines and Streamlines; Velocity Potential - Stream Function - Bernoulli Equation (Theory Only).

Unit – II: Wave Motion **12 Hrs**

Classification of Waves - Derivation of the Velocity Potential - Dispersion Relationship - Celerity in Different Water Depth Conditions - Local Fluid Particle Velocities and Acceleration Under Progressive Waves - Water Particle Displacement Under Progressive Waves - Pressure Distribution Under Progressive Waves - Group velocity - Wave Energy - Wave Power - Simple Problems on Wave Motion. Water Particle kinematics for standing wave - partially standing wave Transformation of wave entering shallow waters - Wave Refraction - Wave Diffraction - Wave Breaking- Types of Wave Breaking - Waves on Currents - Simple Problems on Wave Deformation.

Unit – III: Wave Loads **12 Hrs**

Force Regimes - Design Wave Approach - Morison Equation- Fixed Cylinder in Waves, Fixed Cylinder in Waves and Current - Flexible Cylinder in Wave - Wave Forces on an Inclined Cylinder - Wave Force on a Vertical Cylinder in Deep water - Wave Forces on Piles in Shallow Water - Submarine Pipelines - Froude-Krylov Forces Diffraction Regime - Simple Problems on Wave Loads - Added mass - Definition derivation of added mass for sphere and cylinder in moving fluid, Application to Naval Architecture.

Unit -IV: Finite Amplitude Waves **12 Hrs**

Stokes Wave Theory- Comparison Between Wave Theories - Solitary Wave Theory; Conidial Wave Theory - Stream Function Theory - applicability range of wave theories under different conditions - Simple Problems on Finite Amplitude Waves.

Unit – V: Random Waves **12 Hrs**

Generation of Ocean Waves - Collection of Wave Data - Analysis of Ocean Waves- wave height distribution – Statistical Methods - Spectral Method - Fast Fourier Transform Method – relating wave statistics to spectral parameters – parametric representation of wave spectrum - Directional spectrum – examples of the use of spectral methods to find momentum flux.

Text Books

1. DEAN R.G. & DALRYMPLE RA., (1994), *Water wave mechanics for Engineers and Scientists*, Prentice-Hall Inc. Englewood Cliffs, New Jersey.
2. ROBERT M.SORENSEN, (1993), *Basics wave Mechanics for Coastal and Ocean Engineers*, John Wiley &Sons.

Reference Books

1. PAOLO BOCCOTTI, (2014), *Wave Mechanics and Wave loads on Marine Structures,* Elsevier.
2. SARPKAYA.T ISSACSON .M. (2008), *Mechanics of wave forces on offshore structures,* Van Nostrand Reinhold Co.
3. LEMEHAUTE BERNARD, (1976), *An Introduction to Hydrodynamics and Water waves*, Springer Berlin Heidi Berg.
4. J.J. STOKER, (1992), *Water Waves*: *The Mathematical theory written applications,* John Wiley & Sons.

	Basic Electronics Engineering	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To provide the students with an introductory and broad treatment of the field of Electronics Engineering

Unit - I: Electronics Systems 9 Hrs

Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Unit - II: Transistor and applications 12 Hrs

Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. Cascaded amplifiers, FET and MOSFET characteristics and applications

Unit - III: Feedback in Electronic Systems 9 Hrs

Open loop and closed loop systems, Negative and positive feedback merits and demerits, Principle of oscillators, LC and RC oscillators.

Unit - IV: Integrated & Digital Circuits 12 Hrs

Operational amplifiers, Applications: adder, subtractor, Integrator and Differentiators. Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's).

Unit - V: Electronic Instrumentation & Communication 12 Hrs

Measurement, Sensors, Laboratory measuring instruments: digital multi-meters and Cathode Ray Oscilloscopes (CRO's). Principles of Communication, Need for Modulation, Modulation and Demodulation techniques.

Text Books

1. SALIVAHANAN, N SURESH KUMAR, (2013) *Electronic Devices and Circuits* 3/e, McGraw Hill Publications.
2. BHARGAVA N. N., D C KULSHRESHTHA AND S C GUPTA (2013), *Basic Electronics & Linear Circuits*, Tata McGraw Hill, 2/e.

References Books

1. NEIL STOREY (2011), *Electronics A Systems Approach*, 4/e - Pearson Education Publishing Company Pvt Ltd.
2. R. L. BOYLESTAD & LOUIS NASHLESKY (2007), *Electronic Devices & Circuit Theory*, Pearson Education

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	Structural Design Lab	L	T	P	C	Hrs
		0	0	4	2	72

The student must complete the following

1. Scantling calculations
2. Decks and profile drawing
3. Mid-ship & Bulkhead drawing
4. Structural analysis using suitable software's

* All the drawing to be prepared in AutoCAD

	Basic Electronics Lab	L	T	P	C	Hrs
		0	0	2	1	36

Electronics:

1. Familiarization of electronic equipment and components
2. Studies on Logic gates
3. Using studies on RC and CR networks
4. Studies on Rectifiers and Zener diode regulation
5. Studies on Op. Amp Applications
6. Studies on Flip-Flops and Counters
7. Design or a CE Amplifier
8. Application of Timer 555 chip

	Basic Design Software Lab	L	T	P	C	Hrs
		0	0	4	2	72

The student must complete the following in any one of the ship design software Package

1. Hull modelling
2. Tanks and Compartment definition
3. Intact Stability calculation
4. Damage Stability calculations

SEMESTER 6

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. of Hrs /week
T	Marine Systems	PC	3	3	0	0	3
T	Ship Motion & Control	PC	3	3	0	0	3
T	Ship Design	PC	3	3	0	0	3
T	Business Fundamentals & Economics	HS	3	3	0	0	3
T	Program Elective I	PC	3	3	0	0	3
T	Program Elective II	PE	3	3	0	0	3
P	Ship Design Lab	PC	2	0	0	4	4
P	Hydrodynamics Lab	PC	0	1	0	2	3
	TOTAL		20				25

	Marine Systems	L	T	P	C	hrs
		3	0	0	3	54

Objective: To develop primary knowledge in Auxiliary Machinery and systems, Deck machinery, instrumentation and control.

Unit–I: Pumps and Pumping Systems 9 Hrs

General pumping system characteristics- Classification of Pumps- Displacement - Axial-flow - Centrifugal Pumps- Screw pumps - Ejectors- Piping – various types of piping system fitted in ships- Expansion arrangements for pipes - valves - types of valves and pipes used in Marine Practice- Materials and corrosion in pipes - colour coding for pipes.

Unit - II: Auxiliary Machinery & Systems 21 Hrs

Air compressors- heat exchangers- evaporators- distillers - hot water and drinking water systems - cooling water and sea water systems- Fuel systems - lubricating oil system - filters - coolers - centrifuges - purifiers – Sewage disposal - Oily water separator - incinerator - IMO/MARPOL regulations - Refrigeration system - HVAC. Design of typical ship systems such as Bilge - Fire & Ballast - SW and Fresh water-cooling systems - Ventilation systems - Safety systems – L.S.A. Boats & rafts - emergency equipment – fire fighting systems & equipment - IMO/Class& Statutory Regulations.

Marine boilers: Types - fire tube - water tube boilers - Mounting on Boilers- auxiliary steam plant systems - exhaust gas boilers - composite boilers. Boiler mounting - combustion - feed system - feed water treatment - Boiler capacity - evaporation rate -Waste heat recovery from engine exhaust.

Unit - III: Cargo Handling & Deck machinery 9 Hrs

Mooring - anchor handling - Anchors - anchor chains - cargo handling - dry cargo handling equipment - winches - cranes - cargo hatch covers - liquid cargo tanker systems - Gas cargo systems - cryogenic fluids handling systems - Ballast systems.

Unit–IV: Steering, Navigation & Communication 6 Hrs

Steering gears in marine use – different types – description. Shafting arrangements -stern tubes and glands - oil lubricated stern tubes - shaft seals - shaft alignment - keyless propellers/CPP system and Thrust block - reduction gearing- Shaft grounding system of ICCP. Roll stabilizers and bow thrusters - Auto Pilot - Magnetic & Gyro Compass - Doppler Log - Echo Sounder - RADAR - ARPA - GPS & DGPS - AIS and LRIT - Ariel's and Antennae fitted on board Ships - Communication systems - HF, VHF, SATCOM, NAVTEX and GMDSS - internet on ships - Introduction to EMI/EMC. Introduction to Ergonomics.

Unit –V: Basic Instrumentation & control 9 Hrs

Various Measuring instruments for Pressure - Temperature - Flow - Oxygen analyser- Introduction to Control Theory- Closed loop - Two Step control - P,I,D control system - Basic theory - sensors - transmitters and actuators - typical control system for engine cooling water - boiler feed water -UMS and its requirements. Introduction to digital control systems -

Text Books

1. TAYLOR D.A., (1990), *Introduction to Marine Engineering*, second Edition, Butter worth Heinmann publication.
2. MC GEORGE H.D., (1995), *Marine Auxiliary Machinery*, 7th Edition, Butter Worth Heinmann.

Reference Books

1. HARRINGTON L.R., (1980), *Marine Engineering*, SNAME Publications
2. TECHNICAL & RESEARCH BULLETIN 3-49, (1990), *Marine Diesel Power Plant Practices*, SNAME Publishers.
3. ROWEN ALAN, RAYMOND GARDNER, FEMENIA JOSE, DAVID CHAPMAN and EDWIN WIGGINS (2005), *Introduction to Practical Marine Engineering*, SNAME Publishers.

4. ANTHONY F. MOLLAND, (2008), *The Maritime Engineering Reference Book*, Butterworth Heinemann.

	Ship Motion & Control	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To study the behaviour (motions) of ship in seaway, its controllability and other hydrodynamic aspects.

Unit - I: Introduction to Seakeeping 15 Hrs

Importance of seakeeping analysis - Behaviour of a ship in a seaway. Ship Motions - Surge, sway, heave, roll, pitch and yaw - Characteristics of waves - Sea surface - Regular waves - Sinusoidal and trochoidal wave theories - Analytical and statistical representations - Wave histogram. Standard sea spectra - Average and Significant wave height - Beaufort scale & Sea State code - General Theory of Oscillations - Added Mass - Tuning factor and Magnification factor - Coupled and uncoupled motions - Ship motions in regular waves - Ship motions in irregular waves - Encounter spectrum - Response amplitude operator - Response Spectrum & Motion spectrum - Derived Responses – Local & Relative motions – Added resistance – Powering in waves, Stabilization of ship motions – Control of Roll - Passive (Bilge Keel, Sails, Free Surface Tanks, U-tanks, Moving weight) - Controlled - Passive & Active stabilizers - Control of Pitch.

Unit–II: Sea keeping Performance and Design Aspects 7 Hrs

Measures of Performance - Sea keeping performance criteria and ship seaways responses - Prescribed Limiting values of the seaway Performance criteria - Speed-Polar Plot - Sea keeping performance -Index- SPI-1 & SPI-2, Design Aspects – Factors affecting pitching, heaving & rolling.

Unit–III: Introduction to Controllability 8 Hrs

Introduction to Manoeuvrability - Controlled and uncontrolled motions - The Control Loop & Basic Equations of motion - Definition of Motion stability of ocean vehicles and assumptions of Linearity in Equations of motion - Notation of Force & Moment derivatives -Control forces and moments.

Unit – IV: Course keeping, Model tests & trials 15 Hrs

Analysis of Course keeping and Control - Fixed Stability – Stability Indices – Stability Criterion – Dieudonne's Spiral – Bech Reverse. Definite Manoeuvres – Zigzag Manoeuvre - K & T Course keeping and Turning Indexes - Analysis of Turning Ability – Characteristics of Turning Path - Three phases of Turn - Heel Angle in a Turn, Reduction of speed in a Turn.

Model testing – Free Running Model Tests & Technique, Non-Linear Equations of motion & Captive model tests, Theoretical Prediction of Hydrodynamics coefficients – Semi-Empirical Methods - Regression Analysis & System Identification Methods.

Manoeuvring in restricted waters - Shallow water effects - Bank suction effects- Interaction between ships - Manoeuvring Standards - Special Types of Manoeuvring Devices, Manoeuvring trails - Manoeuvrability & Ship Design.

Unit – V: Control Surfaces 9 Hrs

Hydrodynamics of Control Surfaces – Geometry, Forces & Moments - Flow around a Ship's Rudder - Design of Rudder - Types and characteristics - number of Rudders - Aspect Ratio - balanced & unbalanced Rudder- Rudder Size - Maximum Rudder Deflection - Rudder Deflection Rate - rudder location - Selection of Section Shape - Calculation of steering gear torque and rudder stock diameter.

Text Books

1. LEWIS E.U., (2010), *Principles of Naval Architecture - Second Revision Volume III*, SNAME Publications.
2. BHATTACHARYA R (1978), *Dynamics of Marine vehicle*s, John Wiley & Sons, New York.

References Books

1. LAMB H, (1945), *Hydrodynamics*, Dover Publishers.
2. NEWMAN J.N, (1977), *Marine Hydrodynamics*, MIT Press, USA.

3. PRICE W.G & BISHOP R.E.D, (1974), *Probabilistic theory of Ship Dynamics*, Chapman & Hall, London.
4. CLOYD ARTM, (1989), *Sea Keeping Ship behaviour in Rough weather*, John Wiley & Sons Publishers.

	Ship Design	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To understand the processes involved in designing a ship like - different methods, dimensioning, general arrangement and compliance to statutory rules

Unit – I: Design considerations 14 Hrs

General aspects of Marine Activities, Transportation of cargoes, Marine services & Operations, Marine Industries - Engineering design - philosophy and definition; Marketing principles in marine environment - Classification of marine vehicles on the basis of mission analysis; Properties of cargo and its handling - Design spiral - concept design - Objective and constraints - preliminary design - Hull form design and development - Engineering Economics in Ship Design – economic criteria and complexities, Initial cost, Operating cost – RFR - Owners requirements - optimal vessel design - Freeboard and load line regulation;

Unit - II: Methods of ship design 8 Hrs

Design using basic type ships - Design using coefficients - Design using iteration methods - design spiral- design categories (dead-weight carrier, capacity carrier - linear dimension ship). Ship parameters – displacement - displacement coefficient - displacement equation - volume equation - solution of the cubic equation.

Unit - III: Ship dimension 10 Hrs

Length, breadth, depth, draught, form coefficients - Shape of the hull - Mass estimation - lightship mass – steel mass, outfit mass, engine plant mass - dead weight. Design of hull form – conventional method of lines - distortion of existing forms - stem and stern contours - Bulbous Bow.

Unit – IV: General arrangement 12 Hrs

Subdivision of the ship's hull and erections, arrangement of spaces, arrangement of tanks, superstructure and deckhouses, arrangement of engine plants, Cargo handling capacity Hold capacity and stowage factor Cargo handling equipment's, cargo hatches, lifting devices; Anchor installations – types of anchors, anchor handling system, anchor chain & storage; Mooring systems – deck fittings & structural arrangement, mooring machinery, mooring operations.

crew size, accommodation standards, space allocation, habitability, access, materials, standardization and modular arrangement; Access equipment's –hatches, manholes, doors, other closing & opening devices, load line rules, gang ways and ladders design aspects, connections; Mast & riggings; Railings & awnings superstructure and deckhouses- arrangement of engine plant. Safe Return to Port (SRTP).

Unit – V: Statutory & Commercial Considerations 10 Hrs

Compliance to International and National Rules and Regulations. Building cost estimation. Tender and contract - Introduction to Energy Efficiency Design Index (EEDI) - Introduction to goal based design.

Text Books

1. APOSTOLOS PAPANIKOLAOU, (2014), *Ship Design Methodologies of Preliminary Design*, Springer Publishers.
2. SURESH CHANDRA MISRA, (2015), *Design Principles of Ships and Marine Structures*, CRC Press.

Reference Books

1. THOMAS LAMB, (2003), *Ship Design and Construction*, SNAME Publications.
2. VOLKER BETRAM H. SCHNEEKULTH, (1998), *Ship Design for Efficiency and Economy 2nd Edition*, Elsevier Publishers.

3. D.G.M. WATSON, (1998), *Practical Ship Design*, Elsevier Publisher.
4. ROBERT TAGGART, (1980), *Ship Design and Construction,* SNAME Publications.

	Business Fundamentals & Economics	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To expose the student about the basics of banking, international transactions, company organization and stock market.

Unit – I: Basics of Economics 15 Hrs

Definition - scope and subject matter of economics - a few fundamental concepts like utility, wealth, factors of production, demand and supply, elasticity, equilibrium, land and the laws of diminishing returns - Theory of employment — types of unemployment - concepts of full employment and how it can be achieved - National Income — Gross National Product, Net National Product - measurement of national income - economic growth and fluctuations – consumption - savings and investments.

Unit – II: Banking 9 Hrs

Definition - functions and utility of banking - the principles of commercial banking - multiple credit creation - essentials of a sound banking system. International trade — basic features of import - export.

Unit – III: National & International Financial Institutions 12 Hrs

Industrial Finance Corporation of India (IFCI) - Industrial Credit and Investment Corporation of India (ICICI) - Industrial Development Bank of India (IDBI) - Export-Import Bank (EXIM) - Asian Development Bank - International Monetary Fund - International Bank for Reconstruction and Development (World Bank). Types of Business units — sole proprietorship – partnership - companies - co-operatives - Hindu Undivided Family - Joint Stock companies - public utility services and state enterprises.

Unit – IV: Company organisation and management 12 Hrs

Types of companies - their formation, incorporation and commencement of business - memorandum of association and articles of association – prospectus - shares and debenture - board of directors and general meetings. Business Objectives — concept and rationale of social responsibility - business and its environment - interface with legal, political, economic, social and cultural aspects.

Unit – V: Stock exchange and its workings 6 Hrs

Dealers and brokers' transactions - economic significance - conditions of membership - role of stock exchanges. Business communication and report writing — commercial correspondence and report writing.

Text Books

1. SARAGI S.K, (2011), *Economics Business and Industrial Management*, Himalaya publications.
2. AHUJA H.L., (2016), *Fundamentals of Business Economics*, S. Chand Publications.

Reference books

1. C.B.GUPTA, (2002), *Business Fundamentals*, S. Chand Publications.
2. BHUSAN Y .K. (2000), *Fundamentals of Business Organisation*, S. Chand Publications.
3. GUPTA DN.N.K. & MONIKA CHOPRA, (2016),'' Financial Markets Institutions and Services, Anne Books pvt ltd. Publications.
4. PRASSANNA CHANDER, (2005), *Fundamentals of Financial Management*, Tata Mc Graw hill Publications.

Program Elective I	L	T	P	C	Hrs
	3	0	0	3	54

	Experimental Techniques in Ocean Engineering
	Ocean Energy
	Coastal Hydrodynamics
	Port Planning & Infrastructure Facilities

	Experimental Techniques in Ocean Engineering	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To impart the knowledge of Experimental Techniques in Ocean Engineering and generate models to visualize various structures from prototype structures.

UNIT – I: Modelling Laws 9 Hrs

Model types – history of model testing – purpose of model testing – modelling criteria – planning a model test – general discussion of scaling laws and methods – dimensionality of wave motion – non dimensional hydrodynamic forces – Buckingham PI theorem – Froude's model law – scaling – wave mechanics scaling – current drag scaling – wave drag scaling- hydro elastic structural scaling- distorted model – practical aspects of dynamic similiarity.

UNIT – II: Model construction techniques 12 Hrs

General requirements of models – model types –environmental load models – seakeeping model- submergence model –Jacket launching model – model calibration method – Testing facility – wave generators – mechanical wave maker – pneumatic wave maker –double flapper wave maker- wave tank- current generation – wind simulation – wave absorbing beaches – reflection of regular waves – reflection of irregular waves- limited tank width – testing facilities in the World

UNIT – III: Instrumentation and signal control 12 Hrs

Laboratory measurement techniques, Basics of instrumentation systems, Different types of transducers and their principles : Strain gauges, potentiometers, LVDT, and velocity probes, Current probes, Inclinometers, Accelerometers and their specifications, Pressure transducers and wave probes, Design of load cells and instrumented systems, Signal conditioning

and data acquisition, Sources of noise and errors in instrumentation systems, Filtering, data, and spectral analysis.

UNIT – IV: Modelling of Fixed offshore structures 9 Hrs

Design load computations – Small fixed structures – large fixed structures-gravity production platform – seabed pipeline testing – scour around structures – offshore operations – launching test procedure - Measurement Techniques for Drag and Inertia Forces, floating structures. Modelling of Coastal Structures: Rubble mound Structures.

UNIT – V: Data Analysis techniques 12 Hrs

Standard data Analysis – regular wave analysis – irregular wave analysis – analysis of directional waves – filtering of data –response analysis – analysis of wave force coefficients – Random decrement technique.

Text Books:

1. Langhaar, H.L., (1951) *Dimensional Analysis and Theory of Models*, John Wiley & sons, New York.
2. Thomas G. Beckwith, Roy D. Marangoni, and John H. Lienhard V, *Mechanical Measurements*, 6th Edition, 2009, Prentice Hall.

References:

1. Steven A.Hughes, 1993, *Physical Models and Laboratory Techniques in Coastal Engineering*, World Scientific, Singapore.
2. Chakrabarti, S.K., 1994, *Offshore Structure Modelling*, World Scientific, Singapore.
3. Clayton, B.R. and Bishop, R.E.D., 1982, *Mechanics of Marine Vehicles*, Gulf Publishing Co., USA.
4. Hanna, R.L. and Reed, S.E., 1992, *Strain Gauge-User's Handbook*.

	Ocean Energy	L	T	P	C	Hrs
		3	0	0	3	54

Objective: In the world's present scenario, there is a need for exploring alternative energy sources especially renewable sources like ocean energy. This course will throw light into ocean energy and extraction principles and, create an interest to contribute for the successful extraction of energy from the ocean in the future.

UNIT – I: Introduction to Ocean Energy 9 Hrs

The global energy mix, climate change & sustainability, Introduction to ocean energy sources and types, Methods for ocean observations: Water level Measurements - Tidal poles, tidal gauges, pressure sensors, Radar sensors. Current measurements – Mechanical and electromagnetic current meters, Acoustic Doppler Velocimeter, Acoustic Doppler Current Profiler. Drifters. Wave measurements – Wave rider buoys, Pressure transducers, Remote Sensing Techniques.

UNIT – II: Tidal Energy 12 Hrs

Tide generating forces, progressive waves, Cotidal charts, standing waves, resonance, Coriolis forces, Kelvin Waves, tidal analysis & prediction, compound tides, over tides and tidal asymmetry, characterizing tides at site and power density, tidal stream devices, basic hydrodynamics of horizontal axis turbines and power coefficients & Betz limit, tidal range: lagoons and barrages.

UNIT – III: Offshore Wind Energy 12 Hrs

Introduction and history of offshore wind energy, offshore wind turbines, aerodynamics of wind turbines, power curves, assessment of wind energy at site, case study with calculation of power output & capacity factor, marine spatial planning.

UNIT – IV: Wave Energy 12 Hrs

Wave processes, linear wave theory, dispersion equation, wave energy & wave power, irregular& nonlinear waves, wave transformation due to shoaling water, wave energy convertors, wave resource assessment, survivability & maintenance.

UNIT – V: Other Forms of Ocean Energy 9 Hrs

Ocean currents, Ocean Thermal Energy Conversion (OTEC): Closed & open cycle OTEC, OTEC thermodynamics, Environmental impacts of OTEC, Salinity gradients,

Text Books:

1. Simon P. Neill and M. Reza Hashemi, 2018, *Fundamentals of Ocean Renewable Energy*, Academic Press (Elsevier). ISBN: 978-0-12-810448-4.

2. Deborah Greaves and Gregorio Iglesias, 2018, *Wave and Tidal Energy, John* Wiley & Sons Ltd, ISBN 9781119014454

Reference Books:

1. Roger H. Charlier and Charles W. Finkl, *Ocean Energy: Tide & Tidal Power*, 2009, Springer. ISBN: 978-3-540-77931-5.

2. Arthur Pecher, Jens Peter Kofoed, 2016, *Handbook of Ocean Wave Energy*, Springer. ISSN: 2194-6396.

3. Johannes Falnes, 2004, *Ocean Waves and Oscillating Systems*, Cambridge University Press, ISBN: 0-511-03093-2

4. R. Bhattacharya and M.E. McCormik, *Wave Energy Conversion*, Elsevier Ocean Engineering Book Series, Elsevier

5. Victor Lyatkher, 2014, *Tidal Power*, Scrivener Publishing LLC.

6. Roger H. Charlier and John R. Justus, 1993, *Ocean Energies: Environmental, Economic and Technological Aspects of Alternative Power Sources*, Elsevier Oceanography series. ISBN: 9780444882486.

7. William H. Avery and Chih Wu, 1994, *Renewable Energy from the Ocean: A Guide to OTEC*, Oxford University Press. ISBN 0-19-507199-9

8. Raymond Alcorn and Dara O'Sullivan, 2013, *Electrical Design for Ocean Wave and Tidal Energy Systems*, The Institution of Engineering & Technology (IET), London. ISBN: 9781849195614.

	Coastal Hydrodynamics	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To provide the student with basic knowledge of hydrodynamic processes like wave transformation and flow patterns occurring in the coastal domain.

Unit I: wave mechanics **12 Hrs**

Introduction **-** Characteristics of waves - Classification of waves - wave generation - Different types of wave theories. Two dimensional periodic water wave - solution to linearized water wave - Governing Equations - Velocity Potential – Dispersion relation - water particle kinematics - orbital motion. Group velocity and its dynamical significance - Waves propagation from Deep water to shallow water - wave energy – Problems.

Unit II: shallow water wave transformations **12 Hrs**

Wave transformations – Refraction – shoaling – diffraction - reflection and wave breaking, wave – current interaction. Coastal currents - Longshore current, undertow and rip current. – Seasonal and long term trends in wave action - Morphological evolution of shoreline

Unit III: Wave action in harbour **12 Hrs**

Wave action inside a harbour - harbour resonance - wave dissipation inside a harbour - wave runup and overtopping over different type's breakwaters – wave interaction with harbour structures – overflow – reflection – dissipation forces on structures - Long waves in harbours

Unit IV: Tide and long waves **9 Hrs**

Tides - generation and propagation – observation - Analysis of tide - tidal variation around Indian coast - tidal datum and various levels associated - tidal currents. Storm surge – basics – components – observation - modelling. Sieches - Tsunami.

Unit V: observation and prediction **9 Hrs**

Introduction - collection of wave data - analysis of ocean waves - statistical procedure - regular wave - irregular wave - wave spectra and different types. Wave models - phase resolving and averaging, wave modelling for engineering purposes - design wave parameters - long term statistics.

Text Books

1. DEAN R.G. & DALRYMPLE R.A, (1991), *Water wave mechanics for Engineers and Scientists*, World Scientific Publishing Co. Pte. Ltd.
2. RICHAND L. SILVESTER, (2000), *Coastal Engineering Volume I & II*, Elsevier Publishers.

Reference Books

1. THE OPEN UNIVERSITY, (2000), *Waves, Tides and Shallow Water Processes*, Second Edition, Butterworth-Heinemann.
2. COASTAL ENGINEERING RESEARCH CENTRE, DEPT. OF THE ARMY, (2008), *US Army Corps of Engineers, Coastal Engineering Manual, EM 1110-2-1100*, US Army Corps of Engineers, Washington DC.
3. YOUNG C KIM, (2010), *Handbook of Coastal and Ocean Engineering*, World Scientific.
4. STANISLAW R. MASSEL, (1996)*, Ocean Surface Waves*, World Scientific.

	Port Planning & Infrastructure Facilities	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To expose the student about the basic knowledge of Port Planning and Infra-structure facilities.

Unit – I: Introduction 9 Hrs

Ports - Major Ports - Role of Ports - Terms related to Port – Harbour - classification of Harbour - Vessel characteristics and Dimensions - Ports and harbours as the interface between the water and land infrastructure - an infrastructure layer between two transport media.

Unit – II: Port Planning 9 Hrs

Economic and financial feasibility - Traffic projection - Hinterland development - Statutory clearances - Studies required – DPR - EIA clearance - issues of stakeholders.

Unit – III: Basic requirements 15 Hrs

Tranquillity and Manoeuvrability - Design criteria - site selection and Layout - Environmental conditions - selection of site - Harbour infrastructures - shoreline stability - harbour hydrodynamics. Elements of harbour – navigation channel - turning circle - water front structures - intermodal connectivity - Multipurpose port terminal.

Breakwater: Introduction - Influence of breakwaters on site selection - Relations between breakwater and layout of port - Types of breakwater - Functional requirements – Monitoring – inspection - maintenance and repairs. Material selection - Typical design of Rubble mound breakwater - code provisions.

Unit – IV: Operational and Environmental loads 12 Hrs

Different types of loads - classification - calculation of loads on the structures - Berthing loads and Fender system Design - Mooring loads and Design principles - Geotechnical Design consideration - Code provisions.

Unit – V: Locks and Gates & Maintenance issues 9 Hrs

Introduction - Types of gates - Dry docks – slipways - erosion and accretion - protective structures - Mechanical handling system in Ports - VTMS. Sedimentation - effect of harbour on shoreline stability - maintenance dredging estimation - considerations for disposal.

Text Books:

1. OZA H.P. & OZA G.H., (1990), *Dock and Harbour Engineering*, Anand Publications
2. KATHIROLI .S & NARASIMHAN .S, *Harbour and coastal Engineering (Indian Scenario) Vol I& II*, NIOT Chennai**.**

Reference books:

1. T. SINKER GREGORY, (1997), Hand book of Port and Harbour Engineering, Springer Publications.
2. JOHN W. GAYTHWAITE, (2004), *Design of Marine Facilities For Berthing Mooring And Repair Vessels*, ASCE Publications.
3. CARL SORENSEN, (2010), *Port Designer's Hand Book*, ICE Publications.
4. HANS AGERSCHOU IAN DARD, HANNE L. SEVENDSEN et.al, (2004), *Planning and Design of Ports and Marine Terminals*, Thomas Telford Publications.

Program Elective II	L	T	P	C	Hrs
	3	0	0	3	54

	Introduction to Finite Element Method
	Marine Painting and Corrosion Protection
	Inland Water Transportation

	Introduction to Finite Elements Method	L	T	P	C	Hrs
		3	0	0	3	54

Objective: Familiarize the students with fundamentals of Finite Element Method.

Unit–I: Fundamental concepts 9 Hrs

Introduction, Historical background, Stresses and equilibrium, Boundary conditions, Strain displacement relations, Stress-strain relations, Potential energy and equilibrium: Potential energy, Rayleigh Ritz method, Galerkin's method, Saint Venant's principle, von-Mises stress.

Unit-II: One dimensional analysis 12 Hrs

Introduction, Finite element formulation, Co-ordinates and shape functions, The potential-energy approach, The Galerkin approach, Assembly of global stiffness matric and load vector, Properties of global stiffness matrix, Types of boundary conditions, Simple problems in plane trusses analysis.

Unit-III: Two dimensional analysis 12 Hrs

Introduction, 2-D Finite element formulation, Constant Strain Triangle (CST): isoparametric representation, Jacobian, simple example problems, Orthotropic materials; Four node quadrilateral: shape function, element stiffness matrix, element force vectors, Axisymmetric solids subjected to axisymmetric loading: example case of cylinder subjected to internal pressure.

Unit-IV: Three dimensional analysis 9 Hrs

Introduction, 3-D Finite element formulation: element stiffness, force terms; Stress calculations procedure.

Unit-V: Dynamic considerations 12 Hrs

Introduction, Formulation – Hamilton's principle, solid body with distributed mass, Element mass matrices of – 1-D bar element, truss element, CST element, axisymmetric triangular element, quadrilateral element, beam

element, frame element, tetrahedral element, lumped mass matrix, Eigenvalues and eigenvector evaluation and their properties.

Text Books:

1. TIRUPATHI R, CHANDRUPATLA ASHOK, BELEGUNDU D., (2014), *Introduction to finite Elements in Engineering,* Pearson Education.
2. RAO .S. S., (2011), *Finite Element Methods in Engineering*, Butterworth Heinemann.

Reference books:

1. OLULEKE OLUWOLE, (2011), *Finite Element Modelling for Materials Engineers Using MATLAB*, Springer Publications.
2. IRVING H SHAMES, CLIVE L DYM, (1991), *Energy and Finite Elements in Structural Mechanics*, New age international Publishers.
3. DESAI Y.M., ELDHO T.I., SHAH A.H., (2011), *Finite Element Method with Application in Engineering*, Pearson Education.
4. WAIL N. AL RIFAIE, ASHOK K. GOVIND, (2008), *Finite Element Method for Structural Engineers*, New Age International Publishers.

	Marine Painting & Corrosion Protection	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To develop a Primary knowledge in field of corrosion, surface preparation, paint selection and paint schemes.

Unit – I: Introduction 6 hrs

Corrosion in nature - Corrosion losses - importance of corrosion protection - theories of – corrosion- electrochemical series- types of corrosion - its identification - remedies-factors affecting corrosion – fouling - effect of fouling on ships-factors affecting growth and settlement.

Unit – II: Marine paints & Paint systems 12 hrs

Composition of paints-classification of paints - Primers-mechanism of anticorrosive paint types - selection of paint - paint scheme - antifouling paints-principles of antifouling paints - coating failure. Storage & Application of Paints – Storage - Preparation before application - Application Methods - Application conditions – humidity - temperature-QA & QC-safety & Health. Maintenance of paint systems for ships and offshore structures. Painting contracts and specifications.

Unit – III: Protection of Different parts of Ships under construction. 15 hrs

underwater parts – Boot-top Zone -Topsides and exterior parts on deck & superstructures - Main decks and gangways - cargo holds and tanks - Ballast tanks - Engine rooms - wet & dry accommodation spaces - Requirements for each category and suitable paint systems.

Cathodic protection - Mechanism of cathodic protection - sacrificial anode - design of sacrificial anode system for ship - impressed current system - advantages and disadvantages of cathodic protection. Cathodic protection of offshore structures - control and adjustment of cathodic protection systems - relationship between paints and cathodic protection systems.

Unit – IV: Surface preparation of steel 12 hrs

Degreasing – weathering - mechanical surface cleaning – pickling - blast cleaning - flame cleaning - rust converters - chemical pre-treatment - comparison of pre-treatment methods. Surface preparation of galvanized steel - sweep blasting - chemical treatment - mechanical cleaning - surface preparation of Aluminium - Surface preparation grades & roughness. Prefabrication Primers – Requirements - Blast Cleanliness and surface roughness - Dry Film Thickness - types of Primers

Unit – V: Painting of fixed offshore platforms 9 hrs

Paint systems for submerged zone - tide/splash zone - underdeck area – topsides - working decks and helidecks - high temperature areas - Risers and sea water systems - submerged pipelines.

Text Books:

1. A.M. BERENDSEN, (1989), *Marine Painting Manual*, Graham & Trotman.
2. KENNETH A CHANDLER, (1985), Marine & Offshore Corrosion, Butterworth & Hieneman.

References Books:

1. RAMESH SINGH, (2014), *Corrosion control for Offshore Structures*, Elsevier Publication
2. HARVEY P HACK, (1999), *Designing Cathodic Protection Systems for Marine structures and vehicles*, SNAME.

	Inland Water Transportation	L	T	P	C	hrs
		3	0	0	3	54

Objectives: To expose the students about the knowledge of Inland Water Transportation and its advantages.

Unit - I: Introduction 6Hrs

Characteristics of Inland Water Transport – Major Inland transportation systems in world - Inland water transport in India - Classification of Inland waterways. ; Intermodal transportation – with sea, road and rail.

Unit – II: Types of Inland vessels 12Hrs

Including special types and river sea vessels – Ship dimensions, load draughts. Network of navigable waterways and waterway reaches- Cross section and flow characteristics, locks, bridges, bends and gates. Rules and regulations of Inland Vessels – IV Acts and Role of IWAI.

Unit - III: Elements of Inland water terminals 12Hrs

Navigation channel, turning circle, water front structures, intermodal connectivity. Maintenance issues – sedimentation, siltation bank erosion, maintenance dredging estimation, considerations for disposal.

Unit – IV: Hull shapes of inland vessels 15Hrs

Chine hull forms – development of hull forms – round bilge, chine, multihull- stability of inland vessels- resistance and propulsion of Inland vessels – Shallow water effects – determination of shallow water resistance – Squat and power demand - cross section effects when manoeuvring into and out of lock chambers. Special features – tunnels, shrouded propeller, Inland river vessel design - dumb barges, flotilla/pusher tugs.

Unit – V: General Arrangement 9Hrs

Cargo handling & equipment on board systems – piping system – FFA- LSA-

super structure arrangement, mooring and anchoring. Structural design – material of construction – methods of construction and production technologies.

Text Books:

1. Permanent International Association of Navigational Congress, 1981, Inland & Maritime waterways & ports -Design Construction and Operation Pergamon Press.
2. United Nations, 2003,'' Manual on Modernization of Inland water Transport for Integration within a multi modal transport system '', UNCTAD

Reference Books:

1. BRUCE .L MC CASTRY, 1998, *Inland Navigation locks, dams and Channels*, American Society of Civil Engineers.
2. Economic Commission of Europe, 2011, Recommendation of Harmonized Europe, UNCTAD
3. BOUT WIEGMANS AND TUB MENINGS, 2016, *Inland waterway Transport Challenges & Prospect*s, Routledge.
4. International Navigation Association, 1885, *Guidelines for sustainable Inland Waterways and Navigation,* PIANC

	Ship Design Lab	L	T	P	C	Hrs
		0	0	4	2	72

The following preliminary calculation & drawings for a given input data of a merchant vessel to be prepared by the students in MS office / Auto Cad

1. Equipment Number calculations
2. General Arrangement Drawing
3. Freeboard and tonnage calculations
4. Capacity plan
5. Engine room Arrangement
6. Resistance calculation
7. Rudder design
8. Propeller Drawing
9. Schematic layouts of Bilge /Ballast/Fire & safety systems
10. Structural Fire Protection Plan

	Hydrodynamics Lab	L	T	P	C	Hrs
		1	0	2	0	54

1. Introduction to Ship Hydrodynamics Experimental facilities
2. Ship resistance prediction methods using model tests.
3. Model Preparation for resistance.
4. Running Towing Tests to Obtain Resistance.
5. Calculation to get Ship Effective Power and Form Factor.
6. Introduction to Propulsion tests.
7. Calibration of Load Cell and Dynamometer Force Measurement.
8. Self-Propulsion Test for Wake fraction and thrust deduction fraction.
9. Calculations for Wake and Thrust Deduction Fractions.
10. Introduction on Roll Damping and Ship Motion Tests.
11. Propeller Open Water Test.
12. Ship Roll Damping

SEMESTER 7

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. of Hrs /week
T	Marine Power Plant	PC	3	3	0	0	3
T	Design of Offshore Structures	PC	3	3	0	0	3
T	Humanities Elective I	HS	3	3	0	0	3
T	Program Elective III	PE	3	3	0	0	3
T	Program Elective IV	PE	3	3	0	0	3
P	Ship Design Project & Viva Voce	PW	5	0	0	10	10
P	Industrial Training	MC	0	0	0	0	0
			20				25

	Marine Power Plant	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To enable the students to apply systems design approach to Marine power plant for propulsion and generation of electric power.

Unit-1: Energy Conversion & power plant concepts. 13 Hrs

Energy – sources - types. Conversion of energy from source to end use - energy flow diagrams - systems Engineering concepts in Marine Engineering - ship functions - ship systems and components - underlying physical and electrical principles - economic principles - reliability - availability - maintainability and safety - space weight considerations - control and monitoring. Main components of propulsion system - Prime Mover - transmission & propulsors - propulsion support systems. Types of drives- Direct drive - geared drive - Drives involving steam and gas turbines as prime movers - combined drives with single or multiple shaft lines - Diesel Electric Propulsion and all electric ship concepts - electric drive application in submarines - Hybrid drives - redundancy - engine room layout and machinery arrangement.

Unit-II: Electric Power Generation & Distribution 13 Hrs

Main components of electric power plant - Electric power Demand and Load analysis - simulation of electric power demand - Emergency power estimation. Installation rules for electrical power plant-Choices for emergency power plant - Location of emergency power source. Main Components of electrical system on board ships - Merits and demerits of AC and DC on board. Standard voltages - difference between marine and industrial circumstances - comparison of diesel - thermal and Nuclear power plants as prime movers- shaft driven generators - specification of generators and motors-speed based and torque based motors - power electronics and convertors - harmonic distortion - examples of electric propulsion drives. Distribution systems: Ring and radial system. Earthed or

unearthed systems - three or 4 wire systems - DC systems- Components of distribution system. MSB, SSB and DB, Switchgear for electrical system - protection for generators - preferential tripping -single line layout. Rules governing the distribution system - special rules for tankers and fighting crafts. Transformers for power and lighting-. Specification of transformers. Cables-testing of cables –Megger - design and selection of cables. Installation rules.

Unit-III: Diesel engines & Gas turbines 13 HRs

Working principles of Diesel engines - indicator diagram - performance and efficiency - power and torque - fuel consumption - air consumption - pressure charging - operating envelope - methods to broaden the engine characteristics - power density- specific power related to swept volume and bore - Thermodynamic analysis of Diesel engines- Otto - Diesel cycles and comparison between them - heat and work - MEP & efficiency - limitations. Performance of Diesel Engines- effect of ambient conditions on performance. Thermodynamics of Gas turbines- Brayton Cycle - work & heat - power density and efficiency - losses - effect of regeneration - cycle optimization - potential for advanced cycles - Operating envelope- Power-speed curve - fuel consumption - effect of ambient conditions - Installation on board - COGAS and overall plant efficiency.

Unit IV: Engine selection and Propeller Matching 9 Hrs

Basic matching of propeller and engine - Transformation of ship resistance to engine brake power - off design conditions - effect of off design speed and added resistance - effect of change in number of driven shafts or number of engines per shaft - change of gear ratio and pitch - Change in PTO operating condition.

Unit V: Ship Fuel Consumption and emissions 6 Hrs

Energy Balance for a Ship - Fuel Consumption Ton–Mile considerations, Range and Endurance - Health & Environmental Significance of combustion

products - Measurement & quantification of exhaust emissions-NOx Technical code - ISO8718. Exhaust emissions form shipping and their control measures - SOLAS & MARPOL regulations and Energy Efficiency Design Index (EEDI).

Text Books

1. HANS KLEIN WOUD & DOUWE STAPERSMA, (2014), *Design of Propulsion and Electric Power Generation Systems*, IMAREST Publication.
2. JOHN PROUSALIDIS AND CHRISTOS TH KOURTESIS, (2013), *Ship Electric Energy Systems: Design and Operation Principles*, IMAREST Publication.

Reference Books

1. L.R. HARRINGTON, (1980), *Marine Engineering*, SNAME Publishers.
2. ANTHONY F. MOLLAND, (2008), *The Maritime Engineering Reference book*, Butterworth-Heinemann Publishers.
3. G.O.WATSON, (1990), *Marine Electrical Practice*, Butterworth-Heinemann Publishers.
4. DOUG WOODYARD, (2009), Pounder's *Marine Diesel Engines & Gas Turbines*, Butterworth-Heinemann Publishers.
5. BOSE, INDRA NATH, (2012), *Energy Efficiency and Ships*, IMARE, India.

	Design of Offshore Structures	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To develop understanding about the environmental loading, structural components and design process of offshore structures including accidental loading.

Unit - I: Loads on offshore structures 13 Hrs

Wind Loads- Wave and Current Loads - Calculation based on Maximum base Shear and Overturning Moments - Design Wave heights and Spectral Definition- Hydrodynamic Coefficients and Marine Growth - Fatigue Load Definition and Joint Probability distribution - Seismic Loads.

Unit - II: Steel Tubular Member Design 13 Hrs

Principles of Working Stress Method (WSD) and Load and Resistance Factor Design (***LRFD***) - Allowable stresses and Partial Safety Factors - Tubular Members - Slenderness effects - Column Buckling - Design for combined axial and bending stresses (API RP 2A guidelines).

Unit–III: Tubular Joint Design for Static and Cyclic Loads. 6 Hrs

Simple tubular joints - stress concentration factors - S-N curves and fatigue damage calculations.

Unit–IV: Jack up Rigs 10 Hrs

Configuration and operation of jack ups - Simplified analysis - Spud can penetration and extraction - Spud can – pile interaction - Design of jack up legs.

Unit -V: Design against Accidental Loads 12 Hrs

(Fire, Blast and Collision): Behaviour of steel at elevated temperature - Fire Rating for Hydrocarbon fir - Design of structures for high temperature - Blast Mitigation-Blast walls - Collision of Boats and energy absorption - Platform survival capacity and Plastic design methods 8 Example tutorial problems on design of tubular members - Stress concentration factors - fatigue estimation, wave load on structures

Text Books

1. BARL TROP .N.D.P, (2012), *Floating Structures -A Guide For Design & Analysis Vol I & II*, England oil field Publications Pvt Ltd.
2. W.J. GRAFF, (1981), *Introduction to Offshore Structures Design Fabrication & Installation,* Gulf Publications.

Reference Books

1. MOHAMMED AE. REDDY, (2012), *Offshore Structures Design Construction and Maintenance*, gulf Professional.
2. S.K.CHAKRABARTI, (2005), *Handbook of Offshore Engineering (Vol I & II),* Elsevier.
3. GUNTHER CLAUSS EIKE LEKMANN CARSTEN .O, (2011), *Offshore Structures Vol I & II*, Springer Publications.
4. SRINIVASAN CHANDRASEKAR, (2015), *Dynamic Analysis & Design of Off Shore Structures,* Springer Publishers.

Humanities Elective I	L	T	P	C	Hrs
	3	0	0	3	54

	Entrepreneurship Development & IPR
	Introduction To Operations Research
	Planning For Sustainable Development
	Industrial Management

	Entrepreneurship Development & IPR	L	T	P	C	Hrs
		3	0	0	3	54

OBJECTIVE: The students will be provided with an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

Unit 1: Entrepreneurship 9 hrs

Entrepreneur – Characteristics – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Role of Entrepreneurship in Economic Development – Factors Affecting Entrepreneurial Growth – Economic, Non-Economic, Government Actions

Unit II: Motivation 9 hrs

Entrepreneurial Motivation: Theories and Factors, Achievement Motivation –Entrepreneurial Competencies – Entrepreneurship Development Programs – Need, Objectives – Business Game, Thematic Apperception Test, Self-Rating, Stress management

Unit –III Business 9 hrs

Small Enterprises – Definition, Characteristics, Project Identification and selection – Project Formulation: Significance, content, formulation of project report – Project Appraisal: Concept and method – Ownership Structures: Selection & Pattern

Unit-IV: Financing & Accounting 9hrs

Finance: Need, Sources, Capital Structure, Term Loans – Accounting: Need, Objectives, Process, Journal, Ledger, Trial Balance, Final Accounts – Working Capital Management: Significance, Assessment, Factors, Sources, Management.

Unit-V Support to Entrepreneurs 9 hrs

Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises: Growth Policy, Support. Institutional Support to Entrepreneurs: Need and Support – Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.

Unit-VI Intellectual Property Rights 9 hrs

Law relating to Intellectual property covering Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Other new forms such as plant varieties and geographical indications; International instruments on IP – Berne convention, Rome convention, TRIPS, Paris convention and international organizations relating IPRs, WIPO, WTO etc; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – literary, dramatics and musical works, sound records and cinematographic films, computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Trademarks under Trademark Act, 1999 including Rationale of protection of trademarks as Commercial aspect and Consumer rights, Trademarks, registration, procedures, Distinction between trademark and property mark, Doctrine of deceptive similarity, Passing off an infringement and remedies; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;

TEXT BOOKS:

1. S.S.KHANKA (1999), *Entrepreneurial Development* S. Chand & Co. Ltd. Ram Nagar New Delhi.
2. KURAHKO & HODGETTS, *Entrepreneurship – Theory, process and practices,* Thomson learning 6th edition.
3. WADHERA (2004), *Intellectual Property Rights*, Universal Law Publishing Co.

REFERENCES:

1. HISRICH R D AND PETERS M P (2002), *Entrepreneurship* 5th Edition Tata McGraw-Hill.
2. MATHEW J MANIMALA (2006), *Entrepreneurship theory at cross roads: paradigms and praxis*. Dream tech, 2nd edition.
3. RABINDRA N. KANUNGO (1998), *Entrepreneurship and innovation*, Sage Publications, New Delhi, 1998.
4. CORNISH W. R. (2008), *Intellectual Property Rights, Patents, Trademarks, Copyrights & Allied Rights*, Sweet & Maxwell
5. P. S. NARAYAN (2000), *Intellectual Property Rights*, Gogia Law Agency
6. T. RAMAPPA (2010), *Intellectual Property Rights Law in India*, Asia Law House

	Introduction to Operations Research	L	T	P	C	Hrs
		3	0	0	3	54

Objective: Understand the mathematical tools that are needed to solve optimisation problems.

Unit I: Linear Programming Problems **10 Hrs**

OR-Definition - Phases - models, LP problems formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP.

Unit II: Transportation **10 Hrs**

Transportation problems- Basic feasible solution, optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method Traveling salesman problems - Sequencing models- Johnson algorithm, n job 2 machines, n job 3 machines and n job m machines.

Unit III: Inventory Control **12 Hrs**

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase and Production models with and without shortages- EOQ with price breaks - Stochastic inventory problems - Multi product problems - Systems of inventory control (P and Q Systems)- Determination of buffer stock and re-order levels -Selective inventory control techniques (ABC, VED, SDE, etc.)

Unit IV: Queuing Theory **10 Hrs**

Queuing system - Characteristics - symbols - Poisson process and exponential distribution -Single server queuing models - Multiserver queuing models, Simulation Monte Carlo technique- Inventory & Queuing

problems.

Unit V: Project Management & Replacement Models 12 Hrs

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERT techniques, Critical path and float calculations Replacement models -types of failures – Gradual failures-replacement of items: Efficiency deteriorates with time, sudden failures- individual and group replacement policies.

Text Books:

1. WAYNE.L.WINSTON (2007), *Operations research applications and algorithms*, 4th edition, Thomson learning.
2. G. SRINIVASAN (2010), *Operations research principles and applications*, 2ndedition EEE, PHI
3. HAMDY A. TAHA, (2010), *Operations Research: An Introduction*, Pearson Prentice Hall.

Reference Books:

1. FREDERICK S. HILLIER GERALD .J. LIEBERMANN, (2015), *Introduction to Operations Research 10th Edition*, McGraw Hill.
2. R.PANNERSELVAM, (2004) , *Operations Research*, Prentice-Hall, India,
3. S.D. SHARMA, (1994), Operations *Research 11th Edition*, Kedarnath Ramnath & Co.

	Planning for Sustainable Development	L	T	P	C	Hrs
		3	0	0	3	54

Unit 1: **12 hrs**

Explain and critically evaluates the concept of sustainable development, Environmental degradation and poverty Sustainable development: its main principles, the evolution of ideas about sustainability, strategies for promoting sustainable development, resistances to the concept, and some alternative approaches. Examine some important current issues and areas of debate in relation to sustainable development.

Unit 2: **12 hrs**

Innovation for sustainable development- Environmental management and innovation strategies.

Unit 3: **12 hrs**

Societal transformations. Institutional theory.

Unit 4: **9 hrs**

Governance for sustainable development. Policy responses to environmental degradation.

Unit 5: **9 hrs**

Capacity development for innovation. Research methods.

Text/Reference Books:

1. HARRIS, J.M. (2204) *Basic Principles for Sustainable Development*, Global Development and Environment Institute, working paper 00-04. Available at: http://ase.tufts.edu/gdae/publications/Working_Papers/Sustainable%20Development.PDF
2. ROBINSON, J. (2004) *Squaring the circle? Some thoughts on the idea of sustainable development Ecological Economics* 48(4): 369-

384.

3. HJORTH, P. AND A. BAGHERI (2006) *Navigating towards Sustainable Development: A System Dynamics Approac*h, Futures 38: 74-92.
4. MOG, J.M. (2004) *„Struggling with Sustainability* – A Comparative Framework for Evaluating Sustainable Development Programs“, World Development 32(12): 2139–2160. IISD Commentary on the OECD's Draft Principles for International Investor Participation in Infrastructure (PDF – 68 kb)
5. ARUNDEL, A., R. KEMP, AND S. PARTO (2004) *Indicators for Environmental Innovation*: What and How to Measure, forthcoming in International Handbook on Environment and Technology Management (ETM), edited by D.Annandale, J. Phillimore and D. Marinova, Cheltenham, Edward Elgar.
6. DOUTHWAITE, B. (2002) *Enabling Innovation*. A practical guide to understanding and fostering innovation, London, Zed Books.
7. http://www.sustainability.com/developing-value/definitions.asp
8. *The Challenge of Sustainability*, Global Environment Facility. Washington, D.C: World Bank, 2002.

	Industrial Management	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To equip the student with the knowledge of basic management aspects required in Industrial environment.

Unit - I: Principles & Strategic Management 15 hrs

Functional areas of management - production function - marketing function - finance function - Human resource function - and information technology function. Functions of management like planning - organizing - staffing - directing - controlling - decision making and innovation Strategic Management;

Nature of strategic management - Strategic management process - importance - role of operations management in strategic management - elements of production / operation strategy

Unit - II: Quality Management 9 hrs

Nature of inspection - quality control - statistical quality control - acceptance sampling techniques - total quality management.- modern quality management - process management - benching marking - business process reengineering - quality circles - quality certification

Unit - III: Materials Management 12 hrs

Materials management - objectives of material management - importance of material management - Materials management information systems - materials management organisation - material planning - budgeting - material control - material control cycle

Unit - IV: Enterprise resource planning 6 hrs

What is enterprise resource planning - An ERP system - SAP R/3 - ERP implementation life cycle.

Unit - V: Human Resource Management 12 hrs

Employment: job analysis - Human resources planning - recruitment - selection - placement - induction and orientation. Human resources Development: Performance appraisal - training - management development - career planning and development - Organisation development. Compensation - job evaluation - Wage and salary administration - Bonus - Fringe benefits - social security measures. Human relations - Effectiveness of human resources management - organisational health -human resources accounting - audit research.

Text books:

1. K. ASWATHAPPA, K.SRIDHAR BHATT, (2011), *Production and operations research*, Himalaya Publishing house.
2. SARAGI S.K, (2011), *Economics Business and Industrial Management*, Himalaya Publishing house.

Reference Books:

1. O.P.KHANNA,(2003) *Industrial Engineering and Management*, Khanna publishers Ltd
2. JOHN BANK, (1993), *The Essence of Total Quality Management*, PHI.
3. GREG BOUNDS, LYLE YORKS et al, (1994), *Beyond Total Quality Management*, McGraw Hill.
4. C. B. MAMORIA, S V GANKAR, (2010), *A Text Book of Human Resource Management*, Himalaya Publishing House.

Program Elective III	L	T	P	C	Hrs
	3	0	0	3	54

	Computational Fluid Dynamics
	Computer Aided Design & Manufacturing
	Fishing Vessel Technology
	Ship Recycling

	Computational Fluid Dynamics	L	T	P	C	Hrs
		3	0	0	3	54

***Objective: An introductory course with adequate coverage of mathematical pre-requisites for understanding basics of computational fluid dynamics, the various methods of analysis and applications*.**

Unit-I: Mathematical preliminaries 12 Hrs

Different types of partial differential equations in fluid dynamics - Finite difference method - Finite volume method - Equations of parabolic type and implicit methods - Equations of hyperbolic type and explicit and implicit schemes - Equations of elliptic type and method to handle them - Equations of mixed elliptic-hyperbolic type.

Unit-II: Basic conservation principles 12 Hrs

Unsteady Navier-Stokes equation in integral form and differential form - Boundary conditions for N-S equations - RANS equation, boundary layer, thin layer and associated approximations - Euler equations for inviscid fluids and boundary conditions - The full potential equation, inviscid, incompressible and irrotational flow.

Unit-III: Flow simulation schemes 9 Hrs

Grid generation methods - Inviscid incompressible flow – Potential flow problem and panel methods - Inviscid compressible flow – Numerical solution of full potential equation.

Unit-IV: Simulation of incompressible flow 9 Hrs

Viscous incompressible flow – Incompressible flow computation - MAC method.

Unit-V: Simulation of compressible flow **12 Hrs**

Viscous compressible flow - Dynamic similarity - RANS equations - Turbulence modelling, boundary conditions - Basic computation methods for compressible flow - Solution procedure.

Text Books:

1. NIYOGI PRADIP, CHAKRABARTY S.K., LAHA M.K., (2006), *Introduction to Computational Fluid Dynamics*, Pearson Education
2. ZIKANOV OLEG, (2010), *Essential Computational Fluid dynamics*, John Wiley & Sons.

Reference books:

1. WESSELING PETER, (2009), *Principles of Computational Fluid dynamics*, Springer Publications.
2. RICHARD H. PLETCHER, JOHN C. TANNEHILL, DALE ANDERSON, (2013), *Computational Fluid Mechanics & Heat Transfer*, CRC Press.
3. CHUNG T.J., (2010), *Computational Fluid dynamics*, Cambridge University Press.
4. VERSTEEG, H.K. MALASEKARA W, (2007), *An introduction to Computational Fluid Dynamics*, Pearson Education.

	Computer Aided Design & Manufacturing	L	T	P	C	hrs
		3	0	0	3	54

Objective: To Impart the knowledge of Computer Aided Design and Manufacturing concepts and its applications.

UNIT – I: Computer Aided Design (CAD) 9 Hrs

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

UNIT – II: Engineering CAD systems 12 Hrs

2-D and 3-D transformations, Scaling, rotation, reflection and homogeneous coordinates - Curve representation, Analytical and parametric representation of curves, Differential geometry of curves, Interpolation of techniques, Control polygon techniques (Beziers, B-spline, NURBs) curve generation.

UNIT – III: Generation of geometry 12 Hrs

Ship curve design, Integration and fairing techniques for curves, Surface representation, Analytical and parametric representation of surfaces, Differential geometry of surfaces, Surface interpolation techniques, Control polygon techniques (Beziers, B-spline, NURBs)

UNIT – IV: Computer Aided Manufacturing (CAM) 9 Hrs

Introduction to CAM, Elements and structure of NC, CNC and DNC machines, Introduction to NC part programming and applications, Manual Part programming, Computer Aided Part programming (APT).

UNIT – V: Case study **12 Hrs**

An illustrative exercise covering a select portion of CAD application in ship building.

Text Books:

1. NOWACKI, H. BLOOR MIG &OLEKSIEWIG, (1995), *Computation Geometry for ships*, World Scientific Publishing.
2. Michael .W. Mattson, (2009), *CNC Programming, Principles and Applications*, DELMAR Publishers.

Reference Books:

1. SUBU – QUING LIU DING –YUAN, (1989), *Computational Geometry Curve and Surface Modelling*, Academic Press.
2. WARREN S SEAMES, (2002), *Computational Numerical control, Concepts & Programming*, 4th Edition, Delmar Thomson Learning Inc.
3. FRANCO.PPREPARATIONS, (1985), *Computational Geometry*, Springer.
4. GROOVER .MIKELL P, (1984), *Computer Aided Design and Manufacturing*, Prentice -Hall of India (P) Ltd.

	Fishing vessels Technology	L	T	P	C	hrs
		3	0	0	3	54

Objective: To understand the processes involved in designing a, Fishing vessels.

Unit: I Introduction to Fishing vessels 12 Hrs

Introduction - definitions of fishing vessel - special features of fishing vessels - regulations for the safety of fishing vessels - classification of fishing vessels - fisheries organizations and activities - administrative systems on fishing vessels. Fishery - Characteristics of fish ground - Fishing gear and methods - drift net, long line, drag net, siene net - trawling (side and stern trawlers, single and pair trawling, pelagic & bottom trawling) - Dressing, processing and freezing.

Unit: II Design aspects 12 Hrs

Design Procedure - Owner's specifications - Economy, hull form, investment cost operating revenues and costs - Design of Main Dimensions and form - parent vessel data analysis - space requirement (capacity) of the whole ship estimation of main dimensions - estimation of form coefficients - estimation of light ship weight - estimation of dead weight - design of lines. General arrangement engine room, fish holds, erections, crew accommodation, fuel, fresh-water, ballast tanks, bulkhead positions.

Unit – III: Performance of fishing vessels 9 Hrs

Resistance, powering and propeller - other machinery/equipment - selection of equipment's, navigation, communication –net monitoring. Seakeeping and manoeuvring considerations

Unit – IV construction methods 9 Hrs

Material and construction methods - mechanical properties of materials - comparison of hulls of different material - type of construction - details of steel construction - construction methods in FRP/GRP, Aluminium, Ferro-

cement - Fish holds and preservation facilities - insulation materials and properties - methods fish preservation. Codes and conventions of fishing vessels

Unit – V equipment of fishing vessels 12 Hrs

Deck fitting and deck machinery, fishing equipment on trawlers and seiners, position fixing and fish find equipment, methods of fish preservation on board

Text Books:

1. HENK HENSEN, (2003), *Tugs Use in Port*, The Nautical Institute.
2. FARHAM, (1985), *Design of small fishing Vessel*, Fishing news Books Ltd.
3. DAVE GERR, (2009), *Boat Mechanical systems H*andbook, International Marine/Ragged Mountain Press.
4. LARS LARSSON & ROLF E ELIASSON, (2007), *Principles of yacht design*, International Marine/ McGraw-Hill.

Reference Books:

1. MARCHAJ CA, (1996), *Sail Performance theory and Practice*, Adlard Coles Nautical Publishers.
2. VOSSNACK E, (1990), *Fishing vessels*, Rotterdam NE.
3. M .J. GASTON, (1996), *Tugs Today: Modern Vessels and Towing Techniques*, Patrick Stephens.
4. American society of Civil Engineers, (1994), *Planning and Design guidelines for small crafts Harbour*, American society of civil Engineers.

	Ship Recycling	L	T	P	C	Hrs
		3	0	0	3	54

Unit 1: Introduction **9 Hrs**

Definition of Ship Recycling Relevance of Ship Recycling, Concept of sustainable development of the world 50 Factors contributing to the sustainable development, Role of maritime industrial sector, Statistics of global shipping and ship building.

Unit 2: Ship life cycle stages: **9 Hrs**

Various stages of life cycle of ships, Operations in life stages and effective management of the stages, Importance of ship recycling in life cycle stage management.

Unit 3: Recycling Methods: **9 Hrs**

Decision on decommissioning of ships Preparations for transferring obsolete vessels to Recycling Yards Planning, Commercial matters, Transportation methods, Survey before positioning, Legal matters Positioning of obsolete ships Beaching, Buoy and Dock methods.

Unit 4: Operations in Ship Recycling: **9 Hrs**

Ship dismantling process, Access, Cleaning, Marking, cutting, handling, lifting, sorting, stacking, storing, marshalling, Concept of recycling Reuse and Land-filling in ship recycling Design for ship recycling Vessel specific dismantling: Safety Issues & Ship Recycling Plan.

Unit 5: Rules and regulations in ship recycling: **9 Hrs**

Rule of various international and national agencies, IMO, UNEP (BASEL CONVENTION), EPA (USA), GMB (GUJARATH), ILO, DNV , Statutory Certificates for Ship Recycling , Green passport and Green ship Role of NGOs (Green Peace foundation ,Ban Asbestos Network) Inventory list Safety matters/ requirements Chances of Environmental pollution ,effect on life / organisms at sea.

Unit 6: Ship Recycling Yards: 9 Hrs

Model layout of Ship Recycling yard, ISO recommendations, Application of Information Technology in Ship Recycling.

References:

1. PURNENDU MISRA, ANJAN MUKHARJEE (2009), Ship *Recycling*, *A Hand book for mariners*, Narosa Publication House, New Delhi.
2. *A guide for ship scrappers, tips for regulatory compliance*, United States Environmental Protection Agency, summer 2000.
3. *Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal*,
4. *IMO guidelines on ship Recycling, Resolution A.962 (23)*, 2004.
5. *Industry code of practice on ship Recycling*, Marisec, London, August 2001.
6. *Safety and health in ship-breaking guidelines for Asian countries and Turkey*, International Labour Office, 2004.
7. U.K ship recycling strategy Department for Environment Food and Rural Affairs, February 2007.
8. United Nations Environment Programme, *Conference of the parties to the Basel Convention on the control of Tran's boundary movements of hazardous wastes and their disposal*, UNEP/CHW.6/23.

Program Elective IV	L	T	P	C	Hrs
	3	0	0	3	54

	High Performance Marine Vehicles
	Ocean Acoustics
	Submarines and Submersibles
	Ocean Circulation and Modelling

	High Performance Marine Vehicles	L	T	P	C	hrs
		3	0	0	3	54

Objective: To introduce the students to concepts governing High performing Marine Vehicles and challenges posed to designers.

Unit-I: Classification of high performance vehicles 6 Hrs

Comparison of vehicles on the basis of power - sea keeping and economics - Special design features of high performance vehicles - Materials for high performance marine vehicles; Structural design considerations

Unit - II: High Speed Monohull Crafts 12 Hrs

High speed displacement craft: design procedures, estimation of power, systems design considerations; Planning craft: planning phenomena, estimation of power, hull form design,

Unit – III: Hydrofoil craft 9 Hrs

Foil types and configurations, design of foils, stability when foil borne; Propulsion considerations;

Unit – IV: Air cushion vehicles types 18 Hrs

Air cushion and their effectiveness, cushion sealing arrangements, resistance in calm water and in waves, propulsion and manoeuvring arrangements; surface effect ships;

Unit- V: Hybrid Crafts, HPMV market & Future 9 Hrs

Novel and Hybrid High speed Craft – Ari Cavity Craft – Foil-Assisted Craft – CAT and HYC Compared – Foil- Assisted SWATH – Semi-SWATH CAT with Bulbous Bow – M Craft. HPMV Market – Market Analysis – HPMV Evolution and Competition – Ferry Routes as Driver for HPMV Development – Naval High-speed Vessel Development – Future Prospects

Text Books

2. LIANG YUN, ALAN BLIAULT, (2012), *High Performance Marine Vessels*, Springer Publishers

3. CHRIS B.MCKESSON, (2014), *The Practical Design of Advanced Marine Vehicles Hydrodynamics of High Performance Marine Vessels,* Create space.

4. ODD M.FALTINSEN, (2005), *Hydrodynamics of High -Speed Marine Vehicles*, Cambridge University Press.

Reference Books

1. LIANG YUN, ALAN BLIAULT, (2000), *Theory and design of air Cushion Craft*, Arnold Publishers.

2. PROF. LAWRENCE J. DOCTORS, (2015), *Hydrodynamics for High Speed Vessels*, Create space.

3. DONALD L. BLOUNT, (2016), *Performance of Design Hydrodynamics for High Speed Vessels*.

	Ocean Acoustics	L	T	P	C	Hrs
		3	0	0	3	54

Objectives: The objective of the course is to introduce principles and properties of underwater acoustics through formulation and analysis of transmission, reflection, absorption, attenuation of sound waves in the ocean including boundary and stratification effects.

Unit I: Introduction **9 Hrs**

Physical properties of seawater, Effects of density, salinity and temperature on sound speed. Underwater sound channels (USC). Surface and bottom effects. Ambient noise.

Unit II: Sound Propagation: **9 Hrs**

Wave equation; Helmholtz equation; Lighthill's acoustic analogy; Point source and plane wave solutions; Refraction of sound waves; Snell's Law; Caustics and shadow zones; Ray theory.

Unit III: Reflection and Transmission: 9 Hrs

Changes at an interface between to immiscible liquids. Transmission of sound from air to water and vice versa; Reflection from ocean bottom; Propagation of sound in shallow water.

Unit IV: Sound propagation in Underwater Sound Channel (USC): 9 Hrs

Ray theory for USC; Munk's model; Acoustic field as sum of normal modes; Analysis based on a parabolic equation,

Unit V: Scattering of Sound: 9 Hrs

Scattering at rough boundary surfaces; Method of small perturbation (MSP); Scattering of sound by surface waves and internal waves.

Unit VI: Sound Radiation: 9 Hrs

Generation of sound by marine vehicles and offshore platforms. Application: Remote sensing; Underwater communication; Sonar principle and use; Acoustic tomography; Geophysical seismic exploration

References:

1. M. BREKHOVSKIKH AND YU. P. LYSANOV (1982), *Fundamentals of Ocean Acoustics*, Springer Series on Wave Phenomena (Edited by L.B. Felsen), Springer-Verlag.
2. KINSLER, FREY, COPPENS AND SANDERS (1999), *Fundamentals of Acoustics*, 4th edition.

	Submarines and Submersibles	L	T	P	C	hrs
		3	0	0	3	54

Objectives: To expose the student about the knowledge of Submarine and Submersibles.

Unit – I: Introduction 12 Hours

In general – the submersible system, Inputs to submersible design, basic design of manned submersibles, design objectives, design progression, characteristics and development of submersibles. Environment – physical properties of sea water, dynamical processes, the geographical of the world's ocean basins

Unit – II: Submarine hydrostatics 12 Hours

Principles of flotation, submarines on the surface, arrangement of the main ballast tanks, submarine submerged, buoyancy elements, weight elements, trim and compensating tanks, special tanks, weight / space relationship, general form and arrangement .

Unit - III: Hydrodynamics 12 Hours

Resistance, appendage resistance, sway and heave resistance, resistance estimation of submersibles. Propulsion. Dynamics and control – operation requirement, equation of motion of a submarine, hydrodynamic derivatives, stability and control in the horizontal plane, stability and control in the vertical plane, steering and depth control system.

Unit – IV: Material considerations 12 Hours

Structural principles – pressure hull design, exo structural design. Submarine structure –operational requirement for depth, shape of the pressure vessel, elastic deformation of the shell, buckling deformation of the shell, internal support structures, pressure hull penetration.

Unit - V: Submarine systems **6 Hours**

Hydraulic systems - high pressure air systems - water systems -systems for hydrostatic control - environmental control system - provision for escape, -electrical systems.

Text Books:

1. E. EUGENE ALLMENDINGER , 1990 , " Submersible Vehicle Systems Designs '' SNAME Publications.

2. V.N. KORMILITSIN O.A. KHA LIZEV , 2001 '' Theory of submarine Design '' Reivera Maritime Medias .

Reference Books:

1. ROY BURCHER AND LOUIS RYDILL, 1998, '' Concepts in Submarine Design '' Cambridge University Press.

	Ocean Circulation & Modelling	L	T	P	C	Hrs
		3	0	0	3	54

Unit -I **10 Hrs**

Basics of Ocean Circulation -governing equations: Equation of motion, Dominant forces for ocean dynamics, coordinate system, Types of flow in the ocean, conservation of mass and salt, total derivative, Momentum equation, equation of continuity.

Unit -II **12 Hrs**

Equation of motion with viscosity- turbulence, Reynolds stress, mixing in the ocean, stability. Response of Upper Ocean to wind-Inertial motion, Ekman layer, Ekman mass transport, wind induced surface currents. Warm and cold currents, Gyre system in the basins. Western boundary currents, Equatorial current system.

Unit -III **12 Hrs**

Geostrophic currents –Hydrostatic equilibrium, geostrophic equations, geostrophic currents, geostrophic currents from hydrography, geostrophic currents from altimetry, Lagrangian method of current measurements, Eulerian Method of current measurements.

Unit -IV **10 Hrs**

principles of vorticity dynamics, types of upwelling-coastal, equatorial and open ocean, baroclinic and barotropic instability with applications; Theory of fronts and jets, gulf stream, large scale ocean circulation, ENSO and El nino Southern Oscillation.

Unit -V **10 Hrs**

Numerical Modelling – advantages, Numerical models in Oceanography, Global ocean models, coastal ocean models, coupled ocean atmosphere models, Princeton Ocean Model and some of its applications.

Text Books:

1. Ocean Circulation in Three Dimensions, 2019, *Barry A. Klinger , Thomas W. N. Haine,* Cambridge University Press. ISBN-13: 978-0521768436

2. Numerical Modelling of ocean circulation, 2007, *Robert N. Miller.* Cambridge University Press. ISBN: 9780511618512.

3. Ocean circulation theory, 1998, *Joseph Pedlosky*. Springer. ISBN: 978-3-642-08224-5

References:

1. 1ntroduction to Physical Oceanography, 2008, *Robert H. Stewart.* Texas A & M University.
2. Introductory Dynamical Oceanography, *Stephen Pond, George L. Pickard,* 2nd Ed 1983, Butterworth Heinemann. ISBN: 9780750624961

	Ship Design Project & Viva Voce	L	T	P	C	Hrs
		0	0	10	5	180

Student has to do the preliminary design of an assigned vessel and submit a Project report to the satisfaction of the department. Each Student has to give a seminar talk on his project and appear for a Viva Voce.

	Industrial Training	L	T	P	C	Hrs
		0	0	0	0	0

Objective: To enable to the student to undergo internship in an Industry (preferably maritime related industry) so that he would be able to appreciate some of the knowledge gained so far.

This is a Mandatory, non-credit course in which every student has to undergo Practical training / internship in an industry (preferably marine industry) for 6/8 weeks in the summer vacation after 6th semester. (The student must give report on practical training attended) in 7th semester including a certificate form the authority of the industry that he has attended the training.

SEMESTER 8

Theory/ Practical	Name of the Subject	Category	C	L	T	P	No. of Hrs /week
T	Ship Vibration & Noise	PC	3	3	0	0	3
T	Special Topic Course 1	SP	1	1	0	0	1
T	Special Topic Course 2	SP	1	1	0	0	1
T	Special Topic Course 3	SP	1	1	0	0	1
P	Project Work, Seminar & Viva Voce	PW	8	0	0	16	16
P	Vibration & Noise lab	PC	1	0	0	2	2
P	Comprehensive Viva Voce	PW	5	0	0	0	0
	TOTAL		20				24

	Ship Vibration & Noise	L	T	P	C	Hrs
		3	0	0	3	54

Objective: To familiarize the student with the ship related noise and vibration, their sources and implications on machinery mounting.

Unit – I: Basics of Vibration: 9 Hrs

Introduction, classification of vibration, analysis of single degree freedom systems - Survey of vibration in Ships and Ship Systems – physics of the problem - Structural parts - vibration levels - Vibration of machinery and equipment.

Unit - II: Major excitation sources 15 Hrs

Propeller induced vibration - machinery induced vibration - wave induced vibration - hull girder vibration - double bottom vibration - local hull structure vibration - superstructure vibration - local structure vibration - shaft vibration – torsional - longitudinal and whirling.

Unit - III: Mounting of machinery and equipment 13 Hrs

Introduction - design considerations - characteristics of elastic mounts - operational effects - loads on elastic mounts due to motion in seaway - inertia properties of supported bodies - source isolation - equipment protection.

Unit - IV: Ship noise 12 Hrs

Introduction - airborne noise criteria - acoustic design practices - noise prediction procedures - structure borne noise source levels - transmission paths - noise treatment prediction procedures.

Unit - V: Noise & Vibration Criteria **5 Hrs**

Measurement instrumentation - conditions - locations. Limits of crew and passengers, machinery, local structures. IMO noise limits in cabins, machinery spaces etc.

Text books:

1. NORSKE VERITAS ED, (1985), *Vibration Control in Ships*, Veritec.
2. RAYMOND W. FISCHER, (1985), *Design guide for shipboard airborne noise control,* SNAME Publication.

Reference Books:

1. SHABANA. A.A., (2010), *Theory of vibrations – An introduction 2nd Edition*, Springer Publishers.
2. BALAKUMAR BALACHANDRAN & EDWARD B. MAGRAB, (2009), *vibrations 2nd edition*, Cengage Learning, Canada.
3. VORUS WILLIAM. S, (2010), *Vibration*, SNAME Publishers.
4. GOOD MAN RA, *Wave - Excited Main Hull Vibrations*, LRS Publishers.
5. LEWIS, (2010), *Principles of Naval Architecture Vol – II*, SNAME Publishers.

Special Topic Courses	L	T	P	C	Hrs
	1	0	0	1	18

	Special Topic Course 1
	Special Topic Course 2
	Special Topic Course 3

Special Topic Courses may be offered by faculty of IMU or external experts. These courses shall be announced by the Head of the Department at the beginning of the semester. There shall be internal assessment only for these courses.

	Project Work, Seminar & Viva Voce	L	T	P	C	Hrs
		0	0	16	8	288

Students have to do a group project specialising in any area of the entire course work carried out under the school of Naval Architecture and Ocean Engineering. The Students shall submit a Project report to the satisfaction of the department. Each Student in the group has to give a seminar talk on some of the aspects of the project and appear for Viva Voce.

	Vibration & Noise Lab	L	T	P	C	Hrs
		0	0	2	1	36

Experiments:

1. Measurement of Natural Frequency and Modal Shape of Simply Supported Beam Structure by the Method of Hammer Impact
2. Measurement of Natural Frequency and Modal Shape of Cantilever Beam Structure by the Method of Hammer Impact
3. Measurement of Natural Frequency and Modal Shape of Disc Structure by the Method of Hammer Impact
4. Determination of Damping Ratio (half-power band width method)
5. Determination of Damping Ratio (Attenuation method)
6. A sample Signal Processing and Spectrum Analysis (Software Only)
7. A sample generation of Mechanical Vibration
8. Measurement of Amplitude and Frequency of Simple Harmonic Motion
9. Measurement of Natural Frequency of Vibration System (Lisajours Figure)
10. Measurement of Natural Frequency of Simply Supported Beam (Method of Sine Wave Sweep)
11. Measurement of Natural Frequency of Cantilever Beam (Method of Sine Wave Sweep)
12. Active Vibration Isolation
13. Passive Vibration Isolation
14. Vibration with Single Absorber
15. Vibration with Double Absorber
16. Vibration With Oil Damper
17. Beat Vibration
18. Natural Frequency and Modal Shape of Two or Three Degree of Freedom String
19. Natural Frequency and Modal Shape of Multi Degree of Freedom

String

20. Sound attenuation of materials
21. Noise and vibration measurements to verify within the acceptable limits.
22. Torsional Vibrations of shafting using suitable software.

	Comprehensive Viva- Voce	L	T	P	C	Hrs
		0	0	0	5	0

Viva-voce examination will cover all subjects taught till date.