Detailed Syllabus

Bachelor of Technology Programme

in

Naval Architecture and Ship Building

Revision

(Applicable to regular batches admitted from Academic Year 2023-24 onwards and lateral entry batches admitted from Academic Year 2024-25 onwards)

Table of Contents

Semester I

Course Code	Name of the Course	Category	L	T	P	C	Hrs/ week
	Engineering Mathematics-I	BS	2	1	0	3	3
	Engineering Physics	BS	3	0	0	3	3
	Engineering Chemistry	BS	3	0	0	3	3
	Computer Programming	ES	3	0	0	3	3
	Engineering Graphics	ES	1	0	4	3	5
	Physics Laboratory	BS	0	0	2	1	2
	Chemistry Laboratory	BS	0	0	2	1	2
	English Language Lab	MC	0	0	3	0	3
	Extra Academic Activity 1	MC	0	0	4	0	4
	Total		**12**	**1**	**15**	**17**	**28**

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

Objective: To acquaint the students with mathematical tools and skills required for solving engineering problems

Unit I Mean Value Theorem 07 Hrs.

Rolle's Theorem, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders. Indeterminate forms - Concavity and convexity of a curve, pointsof 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 methodof 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 orderlinear equations with constant coefficients.

Unit III Analytic Functions and 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, 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 Sequences and series 07 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 08 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 acurved 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. and 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. and 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/ Sem
		3	0	0	3	54

Objective: To introduce the basic concepts of physics for students to contribute towards their applications of their broad principles in engineering.

Unit I Heat 09 Hrs.

Thermodynamics: Isothermal expansion of a gas- adiabatic expansion of a gas- changein internal energy of a gas or general gas equation- relation between pressure and volume in a adiabatic process- different forms of adiabatic equation- adiabatic curvesare steeper than isothermal curves- work done by a gas in isothermal expansion- workdone 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 and 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 - CO2 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 velocityand 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 ofa 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 transmissionloss - 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 09 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 ofthermoelectric effect Maxwell's equation and 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 09 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 ofatoms per unit cell - coordination number - atomic radius - packing density - calculation of lattice constant - lattice planes and Miller indices - separation between lattice planesin 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. and GUPTA S.L., (2015), *Engineering Physics*, Dhanpat Rai Publications, New Delhi.
2. AVADHANULU M.N. and KSHIRSAGAR P.G., (1992), *A Textbook of Engineering Physics*, S. Chand Publishing, New Delhi.

Reference Books

1. RESNICK. R, HALLIDAY. D and KRANE. K.S., (2007), *Physics vol 1 and 2*, John Wiley and 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/ Sem
		3	0	0	3	54

Objective: To introduce the basic concepts of chemistry for students to contribute towards their applications of their broad principles in engineering.

Unit I Water and its Treatment 12 Hrs.

Source of water - hard and soft water - determination of hardness - softening water ionexchange process. Boiler feed water operation - caustic embrittlement - internal conditioning. Water for domestic purposes – sedimentation – coagulation - filtration andsterilization - chlorination and its advantages and disadvantages. Disinfection with Ozone. Desalination Pollution – chemical characteristics - sewage treatment biologicaloxygen 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 - hydrogenationof 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 fuelcells - 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 oflubricants - Refractories – Manufacturing – Properties – Classification etc. - Glass – Introduction- Properties of glass –Manufacturing of glass and their types - Cement – Introduction – Manufacturing –Gypsum – Mortar and concretes

Unit IV Electrochemistry 09 Hrs.

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

Unit V Environmental Chemistry 09 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 and 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 Programming	L	T	P	C	Hrs/ Sem
		3	0	0	3	54

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

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 and Object Oriented Programming Methodologies; Program Development in C, Structured Programming - Algorithm, Pseudo-code; The C StandardLibrary, 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 byValue 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 and ADABALA N, (2014), *Computer Fundamentals*, Prentice Hall India Learning Pvt. Ltd.
2. KERNIGHAN.B.W and 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 and E.B. KOFFMANN, (2009), *Problem Solving and Program Design in C*, Sixth Edition, Pearson Education.
4. PAUL DEITAL and 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/ Sem
		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 09 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 09 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. Pearson Publishers
2. JEYAPOOVAN T (2015) *Engineering Graphics using AutoCAD,* VIKAS Publishing House.
3. BHATT, N.D (2016) *Engineering Drawing Plane and Geometry*, Charotar Publishing House
4. GILL P S (2014) Engineering Drawing, Kataria and Sons.

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

Objective: To provide a platform to understand and measure various physical laws

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/ sem
		0	0	2	1	36

Objective: To provide a platform to understand and measure various chemical reactions

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 Redwood 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/ sem
		0	0	3	0	54

Objective: **English Language LAB course focused on Development of oral, Written and communication skills.**

Semester II

Course Code	Name of the Course	Category	L	T	P	C	Hrs/ week
	Engineering Mathematics-II	BS	2	1	0	3	3
	Applied Mechanics	ES	2	1	0	3	3
	Applied Thermodynamics	ES	2	1	0	3	3
	Basic Electrical Engineering	ES	2	1	0	3	3
	Environmental Studies	HS	2	0	0	2	2
	Workshop Practice I	ES	1	0	2	2	3
	Basic Electrical Engineering Laboratory	ES	0	0	2	1	2
	Computer Aided Drafting and Modeling	ES	0	0	2	1	2
	Computer Programming and Simulation Laboratory	ES	0	0	2	1	2
	Extra Academic Activity 2	MC	0	0	2	0	2
	Total		**11**	**4**	**10**	**19**	**25**

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

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

Unit I Matrices 11 Hrs.

Eigen values and Eigen vectors of a real matrix – Characteristic equation – Properties ofEigen values and Eigen vectors – Statement and applications of Cayley - Hamilton Theorem – Diagonalization of matrices – Reduction of quadratic form to canonical formby 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 rectangularparallelepipeds.

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 Convolutiontheorem– Initial and final value theorems – Solution of linear ODE of second order withconstant coefficients using Laplace transformation techniques - Fourier series Dirichlet'sconditions – 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 08 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 and 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. and 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/ Sem
		2	1	0	3	54

Objective: To impart the fundamental principles of equilibrium of bodies underaction 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 coplanarforce 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 commonvolumes - cylinder, cone, sphere, theorem of Pappus.
Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axistheorem, 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 methodof joints and method of sections.
Virtual Work: Equilibrium of ideal systems, work done by a force, work done by acouple, principle of virtual work

Unit IV Kinetics 11 Hrs.

Kinetics: Principles of dynamics - Newton's Laws of motion, D'Alembert's principle inrectilinear 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 andcurvilinear motion, motion under gravity -projectile motion, use of rectangular coordinates, tangential and normal coordinates, radius of curvature, rotation of a rigidbody 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 and 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/ Sem
		2	1	0	3	54

Objective: To understand the principles, laws and properties associated withthermodynamic 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 apure 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 strokeand 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 ofcompressed air.

Unit IV Heat exchangers 06 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 and Air-conditioning 12 Hrs.

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

Need for air conditioning - comfort zone - use of psychrometric charts - basic airconditioning 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 and 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 and Sons, USA.
4. RUDRAMOORTHY R., (2003), *Thermal Engineering*, Tata McGraw Hill, New York, USA.

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

Objective: The objective of this course is to provide the students with anintroductory and broad treatment of the field of Electrical Engineering.

Unit I Introduction 06 Hrs.

Ohms law - Kirchhoff's Laws - series and parallel circuits - source transformations - delta-wye conversion -linearity and superposition theorem with simple examples - Thevenin'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 06 Hrs.

Basic principles of electrical machines - D.C. generators-construction details-principle ofoperation-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 Polyphase 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 threewattmeter methods.

Unit IV A.C. Machines 09 Hrs.

Alternators- principle of operation-types-emf equation (winding factor need not be derived)-synchronous speed-Synchronous motors-principle of operation and method ofstarting-three phase induction motors- construction details of squirrel cage and slip ringmotors-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, Power Generation and Distribution 21 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 transformers.
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 - useof balancer - a.c. transmission single phase and three phase -three wire and four wiredistribution - comparison of d.c. and a.c. transmission - effect of voltage drop - copperutilization under different systems - single and double fed distributors - fuses - d.c. aircircuit breaker - a.c. air and oil circuit breaker- HV and 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/ Sem
		2	0	0	2	36

Objective: To familiarize the students with the environmental issuesassociated with development

Unit I Introduction and Natural Resources 06 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 ofnatural resources and human role.

Unit II Ecosystems, Bio-Diversity and Conservation 08 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.
Definition of Bio-Diversity - 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 III Principles of Circular Economy 06 Hrs.

Linear economy and its disadvantages, development of the concept of circular, linear vs. circular economy, material recovery, waste reduction, butterfly diagram, the concept ofzero waste, circular, business models

Unit IV Environmental Pollution 08 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 08 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 - Environmentprotection act - Wildlife protection act - Forest conservation act - Environmental issuesin 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.
4. LIU, L. AND RAMAKRISHNA, S.(2021.), An Introduction to Circular Economy. Singapore: Springer Singapore.

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/ sem
		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. 900 Round elbow pipes

Foundry

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

	Basic Electrical Engineering Laboratory	L	T	P	C	Hrs/ sem
		0	0	2	1	36

To acquaint students with practical knowledge on electrical circuits, measurements and machinery

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 and Modelling	L	T	P	C	Hrs/ Sem
		0	0	2	1	36

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

Unit I Introduction 02 Hrs.

History and overview: System requirements. Understanding the interface. MainMenu – Organization, screen menu, pull down menu, toolbars and graphic screenand 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 02 Hrs.

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

Unit III Display, Text and other Special Features 02 Hrs.

Using name views, using tiled viewports. 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, scalingof hatch pattern and editing of hatches. Splines – drawing of spline curves, editing splines. Creating regions and boundaries.

Unit IV Object properties, Commands and Dimensions 02 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 alternateunits. Controlling of dimension

variables.

Unit V Blocks definition, layout and plotting 02 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 modelspace. Print settings, properties, paper layout, print scale and plotting.

Unit VI Isometric and 3-D features 02 Hrs.

Isometric drawing concepts. Specifying 3-D co-ordinates, using UCS, viewing in3-D, commands to generate 3-D Solids. Creation of 3-D models of simple objectsand 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 / Practicals :- 24 Hrs.

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

Text Books

1. GEORGE OMURA, BRIAN .C. BENTON (2017), *Mastering AUTOCAD*, Wiley (ISBN: 978-1-119-24005-1)
2. 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 Programming and Simulation Laboratory	L	T	P	C	Hrs/ Sem
		0	0	2	1	36

Objective: To introduce the student on basics of computing, programming andsimulation tool

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

Unit I Practical using Programming language 04 Hrs.

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

Unit II Practical using Programming language 08 Hrs.

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

Unit III Practical using Simulation software 08 Hrs.

Creating a One-Dimensional Array (Row / Column Vector) Exercise – Creating a vectorof 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 andfit post processing.

Unit V Practical using Simulation software 04 Hrs.

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

Text Books

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

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 and E.B. KOFFMANN, (2009), *Problem Solving and Program Design in C*, Sixth Edition, Pearson Education.
4. PAUL DEITAL and HARVEY DEITAL, (2012), *C How to Program*, Seventh Edition, Prentice-Hall.
5. YASHAVANT KANETKAR, (2012), *Let Us C*, twelfth Edition, BPB Publications.

Semester III

Course Code	Name of the Course	Category	L	T	P	C	Hrs/ week
	Strength of Materials	ES	2	1	0	3	3
	Fluid Mechanics -I	ES	2	1	0	3	3
	Engineering Mathematics-III	BS	2	1	0	3	3
	Marine Materials	ES	3	0	0	3	3
	Introduction to Naval Architecture and Ship Building	PC	3	0	0	3	3
	Workshop Practice II	ES	0	0	4	2	4
	Fluid Mechanics Lab	ES	0	0	2	1	2
	Material Testing Lab	ES	0	0	2	1	2
	Extra Academic Activity 3	MC	0	0	4	0	4
	Total		**12**	**3**	**12**	**19**	**27**

Semester III

(Lateral Entry)

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Strength of Materials	ES	2	1	0	3	3
	Fluid Mechanics -I	ES	2	1	0	3	3
	Mathematics Bridge Course*	BS	2	1	0	3	3
	Engineering Mathematics-III	BS	2	1	0	3	3
	Marine Materials	ES	3	0	0	3	3
	Introduction to Naval Architecture and Ship Building	PC	3	0	0	3	3
	Computer Programming**	ES	3	0	0	3	3
	Fluid Mechanics Lab	ES	0	0	2	1	2
	Material Testing Lab	ES	0	0	2	1	2
	Extra Academic Activity 3	MC	0	0	4	0	4
	Total		**17**	**4**	**8**	**23**	**29**

*Specially designed course

** Same as that offered for regular entry in second semester

	Strength of Materials	L	T	P	C	Hrs/ Sem
		2	1	0	3	54

Objective: To understand the fundamentals of how materials behave underthe action of forces such as tension, compression, shear, bending, and torsion.

Unit I Stresses and Strains 11 Hrs.

Concept of Stress and Strain - relationship in deformable solids -Normal, shear andhydrostatic stresses – strains - Poisson's Ratio-elastic constants
- Uni-axial loading - Thermal Stress - Compound Stress and Strain - Principal plane and 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 and number of coils. Strain Energy in torsion.

Unit III Bending Stress 09 Hrs.

Shearing Force and Bending Moment - Sign Convention, Relation between Intensity ofLoading, Graphical construction of Bending Moment and Shear Force diagrams - Bending Stress - Pure Bending - 2nd 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. Strengtheningof Thin Walled Shells. Effect of temperature; volumetric strain on capacity. Thin Curvedbar - Strain energy due to bending Castigliano's theorem, and its application to curvedbars, 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/ Sem
		2	1	0	3	54

Objective: To understand the fundamentals of fluid properties, flow kinematics, conservation laws and applications of fluid fundamentals topractical 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 andirrotational flow - circulation and vorticity velocity potential - stream function.
Equations of motion and energy equation - Euler's equation of motion - conservation ofenergy - 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 and Turbines 09 Hrs.

Hydrodynamic force of jets on stationary and moving plates – flat - inclined and curvedvanes - 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 - Francisturbine - axial flow reaction turbine - Kaplan turbine. Performance of Turbines - SpecificSpeed, unit quantities - unit speed - unit discharge and unit power - performance andcharacteristic curves of hydraulic turbines - main - operating and constant efficiency curves.

Unit IV Pumps 09 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 - primingof 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 06 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. and 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 and 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 and Co., New Delhi.
2. SOM S.R., and 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/ Sem
		2	1	0	3	54

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

Unit I Probability 06 Hrs.

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

Unit II Random Variables 09 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 variancefor 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 ofthe test, the most powerful test and Newman - Pearson Fundamental Lemma, tests forone 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 interms of Sample variance and covariance, regression lines, regression coefficients, the least square parabola, multiple regression, standard error of estimate, linear correlationcoefficient, Probabilistic interpretations of regression and correlation, interpretations ofregression and correlation

Text Books

1. BALI N.P. and 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 and statistics for Engineering and Scientist, Eighth Edition, Cengage Learning.
2. WAL POLE H. MYERS and L. MYERS, (2010), Probability and Statistics for Engineering and Scientists, Ninth Edition, Pearson Education.
3. R.K. JAIN and 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/ Sem
		3	0	0	3	54

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

Unit I Crystal Structure 09 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 09 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 thermoplastics 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 Steeland Aluminium in shipbuilding.

Unit III Solid solutions and Phase Diagrams 09 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 09 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 09 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 theabove 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 09 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 strengthsteels (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 and DAVID G RETHWEISCH, (2013), Materials science and Engineering An Introduction, John Wiley and Sons
2. NARULA G.K., NARULA K.S., and 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 Ship Building	L	T	P	C	Hrs/ Sem
		3	0	0	3	54

Objective: The objective of the course is to provide the learners with a broadappreciation of the science and art of Naval Architecture. Emphasis is given todefine the subject in physical rather than mathematical terms. The learners would be able to grasp a clear understanding of the underlying principles of naval architecture – a design approach and ship building- a practical approach

Unit I Introduction to ships and Naval Architecture discipline 16 Hrs.

Historical review - Ancient types of vessels (rafts, boats, and ships), the role of ship inthe ages of the great discoveries, Role of a Naval Architect in the Maritime Industry.
Types of ships: 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 typeof support - Hydrostatic - Hydrodynamic, aerostatic - Aerodynamic.

Unit II Introduction to ship geometry 08 Hrs.

The ship's hull form - Main particulars – Lines plan (Layout and representation in differentviews) - form coefficients –table of offsets - fairing process. Tonnage. - weights and CG
- volume and capacities. Laws of flotation and stability.

Unit III Evolution of Shipbuilding materials and Machinery 08 Hrs.

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 IV Introduction to ship structures 08 Hrs.

Strength of the hull girder and systems of framing - functions of the shell - decks – shear and camber - bulkheads and hatches. Dynamic effects such as slamming – pounding –panting - racking and shipping green water.

Unit V Terminology of various parts 14 Hrs.

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

Text Books

1. TUPPER E.C., (2013), *Introduction to Naval Architecture*, Elsevier Publishers.
2. K.J. Rawson and E.C. Tupper, *Basic Ship Theory, Vol. I and II, 5th Edition*; Butterworth-Heinemann, 2001

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. D.A Taylor, Introduction to Marine Engineering; 2nd Edition; Butterworth-Heinemann, 1996.

	Workshop Practice-II	L	T	P	C	Hrs/ sem
		0	0	4	2	72

Objective: 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/ sem
		0	0	2	1	36

Objective: To understand the fluid flow phenomenon and explore the methods of measuring the flow discharge and the performance of fluid machinery.

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/ sem
		0	0	2	1	36

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

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

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

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

Unit I Mean Value Theorem 06 Hrs.

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

Unit II Differential calculus of several variables 06 Hrs.

First order differential equations - exact linear and Bernoulli's form - Higher order lineardifferential 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 and Complex Integration 06 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 ofanalytic functions – Conformal mapping: w = z+k, kz, 1/z, z2, eZ and bilineartransformation, 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 thereal axis).

Unit IV Multiple Integrals 06 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 06 Hrs.

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

Unit VI Vector Calculus 06 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 06 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 impulsefunctions – Transform of periodic functions. Inverse Laplace transform.

Unit VIII Partial Differential Equations 06 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 06 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 and 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. and RUKMANGADACHARI E., (2011)
2. Engineering Mathematics Volume II, PEARSON Publishing, London, UK.
3. PETER V. O'NEIL, (2012), Advanced Engineering Mathematics, 7th Edition, Cengage learning, Boston, USA.
4. GLYN JAMES, (2012), Advanced Modern Engineering Mathematics, 3rd Edition, Pearson Education, London, UK.
5. ERWIN KREYSZIG, (2010), Advanced Engineering Mathematics, Wiley International, New Jersey

Semester IV
(Regular entry)

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Fluid Mechanics-II	ES	2	1	0	3	3
	Hydrostatics and Stability	PC	3	1	0	4	4
	Engineering Mathematics -IV	BS	2	1	0	3	3
	Basic Electronics Engineering	ES	2	1	0	3	3
	Welding Technology	ES	3	0	0	3	3
	Basic Structural Analysis	ES	2	1	0	3	3
	Basic Electronics Laboratory	ES	0	0	4	2	2
	Hydro Statistics and Stability Lab	PC	0	0	4	2	4
	Extra Academic Activity 4	MC	0	0	3	0	3
	Total		**14**	**5**	**11**	**23**	**28**

Semester IV
(Lateral entry)

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Fluid Mechanics -II	ES	2	1	0	3	3
	Hydrostatics and Stability	PC	3	1	0	4	4
	Engineering Mathematics -IV	BS	2	1	0	3	3
	Basic Electronics Engineering	ES	2	1	0	3	3
	Welding Technology	ES	3	0	0	3	3
	Basic Structural Analysis	ES	2	1	0	3	3
	Computer Programming and Simulation Laboratory***	ES	0	0	2	1	2
	Basic Electronics Laboratory	ES	0	0	4	2	2
	Hydro Statistics and Stability Lab	PC	0	0	4	2	4
	Extra Academic Activity 4	MC	0	0	3	0	3
	Total		**14**	**5**	**13**	**24**	**30**

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

	Fluid Mechanics-II	L	T	P	C	Hrs/ Sem
		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 07 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 fluidmedium- Magnus effect.

Unit III Viscous Flow 07 Hrs.

Viscosity of fluids - Flow through a pipe of circular section - flow of fluid between parallelplates – 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 boundarylayer - 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. and SETH S.M., (2007), A text Book of fluid Mechanics and Hydraulic Machines, Standard Book House, New Delhi.
2. SOM, S.R. and BISWAS, (1998), Introduction to fluid mechanics and Hydraulic machines, Tata McGraw Hill.
3. K.SUBRAMANYA, (2010), Fluid Mechanics and 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 and Stability	L	T	P	C	Hrs/ Sem
		3	1	0	4	72

Objective: To provide basic principles of generating ship geometry andcalculate its hydrostatic and damage stability

Unit I Introduction and Detailed Lines-plan 16 Hrs.

Hull form definition of ships, Ship's Lines, Displacement and weight relationships, coefficients of form; State of equilibrium, Tonnage – Gross Tonnage and Net Tonnage. 3D Geometry: -Representing 3D objects in 2D views-Orthographic Projection-Orthogonal Planes .Lines Plan : Purpose, -Orthogonal Planes of Reference, Three views
-Body Plan; Half Breadth Plan; Sheer Plan or Profile, Lines Buttocks, Stations; Waterlines. Drawing Offset Table, Types of Stem and Stern profiles, Procedure, Drawing tools, Fairing process.
Bonjeans: Purpose-Calculation of Sectional Areas and Moments -Procedure for Drawing of Area and Moment curves-Sectional area curve – Significance, Parameters obtained from it.

Unit II Integration Rules 16 Hrs.

Introduction; Cross sectional Areas- Water plane area, Transverse section area-Volume-First and Second Moments of Area-Need for Numerical Integration IntegrationRules-Trapezoidal rule-Simpson‵s rules (1-4-1, 1-3-3-1 and 5, 8,-1 rules)-6 ordinaterule-Tchebycheff‵s rule-Application to ship geometry numerical problems

Unit III Intact Stability 12 Hrs.

Initial stability of floating and submerged body - stability at small angles of inclinations – Metacentre, Metacentric height; stability at large angles of inclinations - wall sidedformula. Curve of static stability - angle of loll, cross curves of stability - effect of addition and removal of weights, internal shift of weights - suspended weights - freesurface effect due to partial filling of tanks. Determination of GM - incliningexperiment. 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 Damage Stability 16 Hrs.

Introduction: Archimedes Principle-Weight and Buoyancy-Reserve of Buoyancy Watertight Integrity :-Concept Bilging, Foundering, Capsizing, Plunging- Sinkage andTrim: Lost Buoyancy and Added Weight Methods, Numerical Problems-Watertight Subdivision – Mandatory Bulkheads-Permeability, Bulkhead Deck, Margin Line, Criterion of service Numeral, Factor of Subdivision-Floodable Length and Permissible Length- Calculation and Drawing. Software overview. (Not for External Examination)

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/ Sem
		2	1	0	3	54

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

Unit I Solution of Equations and EigenValue 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-Eigenvalues of a matrix by Power method.

Unit II Interpolation and Approximation 09 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 DifferentialEquations 09 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 orderequations.

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

Finite difference methods for solving two – point linear boundary value problems – Finitedifference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit andimplicit (Crank Nicholson) methods – One dimensional wave equation by explicit method

Text Books

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

Reference Books

1. CHAPRA S.C. and 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. and GREWAL J.S., (2007), Numerical Methods in Engineering Mathematics 9th Edition, Khanna Publishers, New Delhi.

	Basic Electronics Engineering	L	T	P	C	Hrs/ Sem
		2	1	0	3	54

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

Unit I Electronics Systems 09 Hrs.

Introduction to electronics, review of p-n junction operation, diode applications, Zenerdiode 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 09 Hrs.

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

Unit IV Integrated and 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 andDigital to Analog converters (ADC/DAC's).

Unit V Electronic Instrumentation and 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),
3. Basic Electronics and Linear Circuits, Tata McGraw Hill, 2/e.

Reference Books :

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

	Welding Technology	L	T	P	C	Hrs/ Sem
		3	0	0	3	54

Objective: To make students understand Equipments, processes, consumables, safety, defects, quality, and productivity in welding withspecial focus on marine applications.

Unit I Introduction, Advantages of Welding 10 Hrs.

Familiarization of Weld shop, Metal Joining and Cutting Processes: Advantages of Welding Over other Joints, Replacing of Casting, Riveting, Bolting. General condition for welding. Edge Preparation, Weld joints - Butt joints, Fillet joints, intermittent fillet weld,T butt joints, Full Penetration weld, Lap joints, Joint Geometry, Base Metal and it's thickness Factors. Application to ship structures, Workmanship and supervision, Cracking of weld joint, hydrogen induced cracking, HAZ (Heat Affected Zone), Weldingmachines, : AC, DC, Features of Power Sources. Electric Circuit.

Unit II Processes and consumables 12 Hrs.

Welding Process: Solid / Plastic State Welding, Fusion Welding, Gas Welding, Arc Welding, Selection of welding Process, Selection of welding Machines, setting up of Welding Machine, Steps in Executing Welding.
Brazing Process: Torch Brazing, Furnace Brazing, Induction Brazing, Resistance Brazing, Dip Brazing, Infrared Brazing. Welding of Aluminium alloy.
Cutting Process: Carbon Arc Air Gouging /Cutting.
Welding consumables: Welding Consumables, Classification of Welding Consumables, Control of Welding Consumables, Selection of Welding Consumables

Unit III Weld Symbols, Safe Practices, Welding Shop and Heat Application 14 Hrs.

Safe Practices: Eye and Face Protection, Protective Clothing, Noise, Machinery Guards,Fumes and Gases, Exposure Factors, Ventilation, Handling of compressed gases, Manifolds, Gases, Electric Shock, Protection of Welders and Others
Weld Symbols: Weld and Welding Symbols, Supplementary Symbols, Supplementary Symbols
Weld Process characteristics: Deposition Rate, Deposition Efficiency, Operating Factor,Penetration, Welding Speed, Heat Input, Power Density, Heat Affected Zone
Welding Shop: Oxy-Acetylene System, Arc Welding Equipment, Spot Welder, Metal Cutting Equipment, Furnaces, Equipment for material movements, Jigs and Fixtures, Rotators, Power Tools, Surface Cleaning Equipment, Weld Test

Equipment
Heat Application: Heat Application of Base metal, Heat input Controls, Preheating, Annealing, Post weld Heat Treatment. Surfacing, Hard Facing, Buttering.

Unit IV Welding Distortions, Defect and NDE 12 Hrs.

Welding Distortions: Factors leading for material distortion, Minimizing Weld distortion Quality control in welding: Monitoring, Inspection of Final Welds, Dimensional Control, Documentation. IACS standard for quality inspection, mismatch and deformation tolerances accepted by the IACS,
Types of discontinuity and Defects : Base Metal Discontinuity and Defects, Weld metalDiscontinuity and Defects, Defects due to base material, Defects due to Filler material,Defects due to process deficiency, Defects due to welding technique, Defects due to Inexperienced welder. Remedies. Replacement.
NDE: Visual Inspection/Examination (VT), Magnetic Particle Examination (MT), Liquid Penetrate Examination (PT), Ultrasonic Examination (UT), Radiographic Examination (RT), Eddy Current Examination (ET), Leak Proof Examination.

Unit V Quality, Productivity 06 Hrs.

Qualification and inspection: Drawings, Codes, Standards, Specification, Control Materials, Alloy Identification, Qualification of Welding Procedures, Qualification of Welder Performance, Qualification of Welding Consumables
Welding Estimation: Welding Consumable Calculation, Arc Time Calculation, Man HourCalculation, Weld Cost Calculation
Welding Productivity: Factors Affecting Welding Productivity, Welding Process Efficiency, Welding Process Selection, Productivity Improvement Tips.

Text Books

1. Davies, A.C.; Welding, Cambridge University Press, Low Price Edition, 1996.
2. Richard, Little; Welding Technology, McGraw Hill Publications, New Delhi, 2001.
3. Joe Lawrance; Welding Principles for Engineers, Prentice-Hall Inc. Englewood Cliffs, N.J., 1951.

Reference Books

1. Welding Handbook – Vol.:1, 2, 3; American Welding Society, 1991.
2. O.P. Khanna; A Textbook of Welding Technology, Dhanpat Rai andSons, 2011.
3. G.D.Garg, A text book of welding technology, S.K.Kataria and Sons, 2012.
4. Sreenivasan N.K, Welding Technology, Khanna, 2008.
5. Baldev Raj, Welding Technology for Engineers, ASM International, 2006.
6. David J. Hoffman Welding, Pearson Publication,2017.

7. Khan, M.I. Welding Science and Technology 1 PB 280 2007 New age Publication.
8. Radhakrishnan, V.M. Welding Technology and Design 3 HB 895 2019 New age Publication.

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

Objective: To introduce to the students the methods and processes requiredto 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 ofbeams, Failure Theories, Fatigue and Fracture: Fatigue analysis – SN curve and Fatiguedamage accumulation and calculation, Low cycle Fatigue and high cycle Fatigue. Fracture analysis – Linear Elastic Fracture Mechanics, crack propagation, Fracture toughness.

Unit II Continuous beams 09 Hrs.

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

Unit III Portal frame method 09 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 12 Hrs.

Computer implementation of matrix method – General format of structural analysis, various numerical schemes for – solution of simultaneous equations, solution to Eigenvalue 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 and IBH Publishing Co.
2. TIMOSHENKO and YOUNG (1965); Theory of Structures, McGraw Hill Publications.
3. RUSSELL. C. HIBBELER (2014); Structural analysis. Ed. 9, Prentice Hall.

	Basic Electronics Laboratory	L	T	P	C	Hrs/ sem
		0	0	4	2	36

Objective: To familiarize students to electronics equipment and the principles of the working of electronic components and equipment

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

	Hydro Statistics and Stability Lab	L	T	P	C	Hrs/ sem
		0	0	4	2	72

Objective: The following drawings and 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 V

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Ship Construction and Repair	PC	2	1	0	3	3
	Resistance and Propulsion	PC	3	1	0	4	4
	Ship Production Technology	PC	3	1	0	4	4
	Marine Machinery and Systems	PC	3	1	0	4	4
	Industrial Management	HS	3	0	0	3	3
	Structural Design Lab I	ES	0	0	6	3	4
	Technical English Communication and Soft Skills	HS	1	0	2	2	3
	Basic Design Software Lab	PC	0	0	6	3	4
	Total		**15**	**4**	**14**	**26**	**29**

	Ship Construction and Repair	L	T	P	C	Hrs/ Sem
		2	1	0	3	54

Objective : To impart the knowledge on shipbuilding materials, structuralarrangement and the repairing techniques

Unit I Types of Ships, Materials and Structural Systems 12 Hrs.

Types of Ships-Inland Vessel, Seagoing Vessel, Naval Ships – types, general description, uses. Ship building and launching terms.
Ship building materials – transition from wood to steel, shipbuilding quality steels (properties, steel grades) – Riveting - Welding, 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 II Bottom, Side and End Structures 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.Fore end structure – functions, structural arrangements (panting), structural components - After end structure – functions, structural arrangements, structural components - Structural connections – compatibility, bottom and side, side and deck, bulkhead with deck, side and bottom -Chain locker and hawse pipe - Rudder construction.

Unit III Engine Room, Super structure and Outfitting 10 Hrs.

Engine room – functions, general arrangement, engine casing, foundations, Superstructure and Deckhouses – functions, structural arrangement, effectiveness of superstructure and 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 paneling.

Unit IV Repair of Ship Hull 10 Hrs.

Repair of ship hull – Introduction; cause of wear and damage in ship 's hull: Comparison between different types of repair activities (Afloat, berthed, etc.); Repair of hull and other parts while afloat, docking plan-replacement of hull plates and stiffeners, decksand bulkheads; repair of stem and stern frames and shaft bracket; NDT and X-ray tests. Testing for water-tightness and hull continuity etc.

Unit V Underwater Welding 10 Hrs.

Underwater welding – welding equipment; quality control and standards; degree of automation. Safety during repair – various operations involving risk, safety devices andplans, problems during docking. Ship repair facilities in a modern repair yard-repair docks, machine shop, scaffolding; Subcontracting policies by shipyard in repair project,layout of repair yard.

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 and RICHARD C. MOORE, (1995), Ship Production, Society of Naval Architects and Marine Engineers.
5. DEV A.K., SAHA M., and BRUCE G., (2022), Ship Repairing: Analyses and Estimates (Vol. 12). Springer Nature

	Resistance and Propulsion	L	T	P	C	Hrs/ Sem
		3	1	0	4	72

Objective: Provide fundamental understanding of various ship resistancecomponents, 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 andresistance - 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 - CirculationTheory. 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 09 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 BladeSection – Approximate Methods – classification society Requirements - PropellerMaterials.

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 DesignUsing 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*, KnowledgeWorld Publishers Pvt Ltd.

Reference Books

1. JOHN CARLTON, (2012), *Marine Propellers and Propulsion 3rdEdition*, Butterworth Heinemann.
2. S.V.A. HARVALD, (1983), *Resistance and Propulsion of ship*, WileyInter science Publications.
3. MOLLAND F., DOMINIC A. HUDSON & STEPHEN R. TURNOCK, (2011), *Ship resistance and Propulsion*, Cambridge University Pre

	Ship Production Technology	L	T	P	C	Hrs/ Sem
		3	1	0	4	72

Objective : To impart the knowledge of ship production i.e., fabrication ofparts, assembly, erection of ship hull, launching and different technologiesadopted in ship production

Unit I Characteristics of Ship Building 16 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 16 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 16 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 16 Hrs.

General assembly methods - Handling of preassembled units in the erection area – Cranes, heavy duty truck - Preassembly of blocks – Hull assembly, different methods ofhull 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 08 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 ofNaval 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.

	Marine Machinery and Systems	L	T	P	C	Hrs/ Sem
		3	1	0	4	72

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

Unit I Pumps and Pumping Systems 12 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 andpipes used in Marine Practice- Materials and corrosion in pipes - colour coding for pipes

Unit II Auxiliary Machinery and Systems 21 Hrs.

Air compressors- heat exchangers- evaporators- distillers - hot water and drinking water systems - cooling water and seawater systems- Fuel systems - lubricating oil system -filters - coolers - centrifuges - purifiers – Sewage disposal - Oily water separator - incinerator - IMO/MARPOL regulations - Refrigeration system - HVAC. Design of typicalship systems such as Bilge - Fire and Ballast - SW and Fresh water-cooling systems - Ventilation systems - Safety systems – L.S.A. Boats and rafts - emergency equipment
– fire fighting systems and equipment - IMO/Class and 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 and Deck Machinery 12 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 and Communication 18 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 and Gyro Compass - Doppler Log - Echo Sounder - RADAR - ARPA - GPS and 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 and control 09 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. McGEORGE H.D., (1995), *Marine Auxiliary Machinery*, 7th Edition, Butter WorthHeinmann.

Reference Books:

1. HARRINGTON L.R., (1980), *Marine Engineering*, SNAME Publications
2. TECHNICAL and 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

	Industrial Management	L	T	P	C	Hrs/ Sem
		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 technologyfunction. 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 09 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 06 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 – organizational health -human resources accounting - audit research.

Text books:

1. K. ASWATHAPPA, K.SRIDHAR BHATT, (2011), *Production and operations research*, HimalayaPublishing 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.

	Structural Design Lab I	L	T	P	C	Hrs/ sem
		0	0	6	3	72

Objective: To introduce students to the basic concepts of ship structuraldesign

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

   * All the drawing to be prepared in AutoCAD

	Technical English Communicationand Soft Skills	L	T	P	C	Hrs/ Sem
		1	0	2	2	54

Objective: To build proficiency in technical writing, Oral Communications andPersonality Development.

Unit I English for communication 18 Hrs.

Technical vocabulary, Synonyms and Antonyms, Numerical adjectives, Conjunction andPreposition 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 09 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 09 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 09 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 09 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.

	Basic Design Software Lab	L	T	P	C	Hrs/ sem
		0	0	6	3	72

Objective: To introduce students to hydrostatics and stability design

Students must complete the following in any one of the ship design application software

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

Semester VI

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Ship Outfitting	PC	3	0	0	3	3
	Ship Motion and Control	PC	3	1	0	4	4
	Ship Design	PC	3	0	0	3	3
	Shipping Practice	PC	3	0	0	3	3
	Ship Vibration and Noise	PC	3	0	0	3	3
	Program Elective I	PE	3	0	0	3	3
	Program Elective II	PE	3	0	0	3	3
	Structural Design Lab II	ES	0	1	2	2	3
	Marine Systems Lab	PC	0	1	2	2	3
	Total		**21**	**3**	**4**	**26**	**28**

Programme Elective I	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Ship Recycling	PE	3	0	0	3	3
Marine Painting and Corrosion Protection	PE	3	0	0	3	3
Ocean Acoustics	PE	3	0	0	3	3
Renewable Energy in Maritime Sector	PE	3	0	0	3	3
Programme Elective II	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Composite Boat design and Construction	PE	3	0	0	3	3
Traditional Boat Building Techniques	PE	3	0	0	3	3
Fishing Vessel Technology	PE	3	0	0	3	3
Submarine and Submersibles	PE	3	0	0	3	3

	Ship Outfitting	L	T	P	C	Hrs/ Sem
		3	0	0	3	54

Objective: To make students understand Ship deck outfitting, internal and External outfitting and engine room fitting - components, arrangements and their uses with the aim of the students understand the ships components,their layout and its construction.

Unit I Deck Outfitting-I 12 Hrs.

Super structure, E/room and Deckhouses: Location, uses, constructional features. Arrangement of Anchor and chain cable : preparation of mock up of anchor and chain cable arrangement prior to outfitting of naval pipe (spurling pipe) , hawse pipe, deck stoppers, capstan, windlass, alignment of capstan and under slung motor, cleats. Bitter end. Equipment number, and calculations, Masts, Derricks, Navigation deck : Types of masts, Main mast, fore mast, Mast fittings, Lattice mast, Plated mast and advantages Tripod and Pole mast, Fitting ofmast, fitting of mast with halyards. Navigation lights, antennas, radar, horn, search light, window wipersMain deck : safety walkway, Gangway, accommodation ladder

Unit II Deck Outfitting-II 12 Hrs.

Cargo Access, Handling and Restraint: Stern and Bow doors, Ramps, Side doors and Loaders, Portable decks, Scissors Lift, Cargo restraint. Cargo hatch covers differenttypes, cargo tank hatch covers, Sampson Posts, Derrick rigs, Deck cranes. Davits,different types of davits, super structure fitting of davits.
Doors and Manholes: Details of doors, watertight doors, Weather tight doors, non-Watertight doors, embossed doors, Mesh doors, hatches, manholes, raised and flush manholes.
Mooring and Towing arrangement: arrangement of bollard and Fairleads on the main deck, berthing and towing arrangements. Bitts, Cruciform, Deadman, chalks, rollers, wires, ropes, fenders. Bollard pull and tugs.
Ladders: Ladder arrangement, different types of ladder arrangement in accommodation area, engine room and store room, Brows.
Cable and ventilation: outfitting of cable tray, cable hangers, piping and ventilationtrunking,
LSA outfitting: Fitting of life raft and life buoys, lifeboats and rescue boats.

Unit III Internal Outfitting 12 Hrs.

Internal outfitting, Accommodation, Construction detail of : maintenance of minimum head room of 1.8m after completing ceiling, Composite Drawing of Internaloutfitting, outfitting of messes, lay out of messes, Officers and crew

cabins, electronic compartments, acoustic and thermal insulation, A/C and heating arrangements, outfitting of furniture, out fitting of galley, servery and scullery, line out inspection, galley equipments, lining in galley, out fitting of cold and cool room, temperature maintenance, out fitting of laundry and drying room, out fitting of WCs, declivity of soilpipe and routing of soil pipe, out fitting of different store rooms, outfitting of sick bay,arrangement of a/c trunking in sick bay, electronic compartment

Unit IV Engine Room Outfitting 10 Hrs.

Engine room – functions, general arrangement, engine casing, foundations Funneluptakes **-**Down take and uptake of main machinery, Gas turbine uptake, Boiler uptake. Systems - FW systems, SW systems, firefighting systems. Pumping and Piping arrangements: Bilge and ballast pumping and piping. Generalservice pipes and pumping, Sea inlets, Air and sounding pipes, hot water, scupperdrainage.

Unit V External Outfitting 08 Hrs.

Rudder: Determining type and size, Balanced and semi balanced rudder, plate rudder, streamlined rudder, Propellers and types, thruster, Stabilizers

Text Books:

1. SINGH, R. (2007) The process of ship building - The Institute of Marine Engineers
2. Stokoe, E.A., (1985), Reed's Ship construction for marine students Vol.5. Stokoe, E A - 9780713671780 - Adlard Coles Nautical

Reference Books:

1. EYRES D.J (2006). Ship construction. Elsevier.
2. GILLMER, T.C. and JOHNSON, B. (1982) Introduction to naval architecture (Vol. 3). Annapolis: Naval Institute Press

	Ship Motion and Control	L	T	P	C	Hrs/ Sem
		3	1	0	4	72

Objective: To study the behavior (motions) of a ship in seaway, its controllabilityand other hydrodynamic aspects.

Unit I Introduction to Sea keeping 22 Hrs.

Importance of sea keeping 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 15 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 10 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 forcesand 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 – ZigzagManoeuvre - 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 ofspeed in a Turn.

Model testing – Free Running Model Tests & Technique, Non-Linear Equations of motion &Captive model tests, Theoretical Prediction of Hydrodynamics coefficients – Semi-EmpiricalMethods - Regression Analysis & System Identification Methods. Manoeuvring in restricted waters - Shallow water effects - Bank suction effects- Interactionbetween ships - Manoeuvring Standards - Special Types of Manoeuvring Devices, Manoeuvring trails - Manoeuvrability & Ship Design.

Unit V Control Surfaces 10 Hrs.

Hydrodynamics of Control Surfaces – Geometry, Forces & Moments - Flow around a Ship'sRudder - 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 geartorque and rudder stock diameter.

Text Books

1. LEWIS E.U., (2010), *Principles of Naval Architecture - SecondRevision 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 ShipDynamics*, Chapman & Hall, London.
4. CLOYD ARTM, (1989), *Sea Keeping Ship behaviour in Rough weather*,John Wiley & Sons Publisher

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

Objective: To understand the processes involved in designing a ship like - differentmethods, 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; Marketingprinciples in marine environment - Classification of marine vehicles on the basis of missionanalysis; 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 08 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, anchorchain & 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) - Introductionto 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.

	Shipping Practice	L	T	P	C	Hrs/ Sem
		3	0	0	3	54

Objective: To understand the different elements of Shipping Practice

Unit I National and International Scenario 12 Hrs.

National Development Programs-Overview, current scenario, Analysis of the program,Need for coastal shipping, Government action/support, Advantages to shipping & trade,limitations, Legislation, Current scenario, IWAI –its objectives, current scenario,analysis.
Indian & International Shipping Organizations-INSA, BIMCO, ICHA. FONASBA, Baltic Exchange, INTERCARGO, Transchart, FIATA etc.
Shipbuilding, Ship Repairs & Ship breaking (with special ref to India) Government support, subsidies, Current scenario

Unit II Ship Vetting 09 Hrs.

Need for ship vetting, Definition, Standard contracts for ship vetting, Flag State andPort State Control-Meaning, scope, responsibility

Unit III Logistics and Supply Chain Management 12 Hrs.

Logistics concept & definition, supply chain management, Differences between logistics and SCM, Key players in logistics-suppliers, carriers, warehousing etc,3PL& 4PL concept

Unit IV Maritime Corruption and Piracy 09 Hrs.

Maritime Corruption-Definition-Types of corruption, Current Scenario Role of MACNMaritime Piracy-Origin, Piracy attacks current scenario, role of IMB

Unit V Maritime Cyber Security 12 Hrs.

Meaning of Electronic Data Interchange (EDI), standards & their evaluation, EDI in India –Problems & prospects, problems in development of EDI in India, document exchange Maritime Cyber Security Need.

Text Books :

1. BRANCH, A.E., 2012. *Economics of shipping practice and management*. Springer Science & Business Media.
2. STEVENS E., AND BUTTERFIELD, C.S.J.,(1981), *Shipping Practice,* 11th Edition
3. ABRAMS, N., BEALE, S.S. and KLEIN, S.R., (1986), *Federal criminal law and its enforcement* (pp. 32-62). West Publishing Company.
4. BOWDEN, A. (2010), The economic cost of maritime piracy.
5. FITTON, O., PRINCE, D., GERMOND, B. and LACY, M.,(2015), *The future of maritime cyber security*.

Reference Books:

1. EXIM India Newspaper
2. Times Shipping Journal

	Ship Vibration and Noise	L	T	P	C	Hrs/ Sem
		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 09 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 treatmentprediction procedures.

Unit V Noise and Vibration Criteria 05 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 and EDWARD B. MAGRAB, (2009),
3. vibrations 2nd edition, Cengage Learning, Canada.
4. VORUS WILLIAM. S, (2010), Vibration, SNAME Publishers.
5. GOOD MAN RA, Wave - Excited Main Hull Vibrations, LRS Publishers.
6. LEWIS, (2010), Principles of Naval Architecture Vol – II, SNAME Publishers.

Programme Elective I	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Ship Recycling	PE	3	0	0	3	3
Marine Painting and Corrosion Protection	PE	3	0	0	3	3
Ocean Acoustics	PE	3	0	0	3	3
Renewable Energy in Maritime Sector	PE	3	0	0	3	3

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

Objective: To make students understand the Ship recycling industry, itsprocess, stages, methods and regulations on it.

Unit I Introduction 09 Hrs.

Definition of Ship Recycling. Relevance of Ship Recycling. Concept of sustainable development of the world. Factors contributing to the sustainable development, Role ofmaritime industrial sector, Statistics of global shipping and ship building, Financial Implications, Circular economy.

Unit II Ship life cycle stages 09 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. Hazardousmaterial, inventory.

Unit III Recycling Methods 09 Hrs.

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

Unit IV Operations in Ship Recycling 09 Hrs.

Ship dismantling process, Access, Cleaning, Marking, cutting, handling, lifting, sorting,stacking, storing, marshaling, material recovered, waste generated. Concept of recycling Reuse and Land-filling in ship recycling. Design for ship recycling. Vessel specific dismantling. Health, safety, environmental Issues and Ship Recycling Plan. Riskassessment. Hazardous waste management. , Carbon foot printing of Ship recycling process.

Unit V Rules and regulations in ship recycling 09 Hrs.

Rule of various international and national agencies, IMO, Hong Kong convention, 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 VI Ship Recycling Yards 09 Hrs.

Major Yard locations, 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.
9. IMO WEBSITE , MEPC -196, 210, 211, 269, 222, 223

	Marine Painting and Corrosion Protection	L	T	P	C	Hrs/ sem
		3	0	0	3	54

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

Unit I Introduction 06 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, Cavitation – induced corrosion on propeller blades.

Unit II Marine paints and 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 and Application of Paints – Storage - Preparation beforeapplication - Application methods - Application conditions – humidity - temperature-QA and QC-safety and Health. Maintenance of paint systems for ships and offshore structures, Fire resistance 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 and superstructures - Main decks and gangways - cargo holds and tanks - Ballast tanks - Engine rooms - wet and dry accommodation spaces - Requirements for each categoryand 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 and roughness. Prefabrication Primers – Requirements - Blast Cleanliness and surfaceroughness - Dry Film thickness - types of Primers

Unit V Painting of fixed offshore platforms 09 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 and Trotman.
2. KENNETH A CHANDLER, (1985), Marine and Offshore Corrosion, Butterworth and 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.

	Ocean Acoustics	L	T	P	C	Hrs/ sem
		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 10 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 10 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 12 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 10 Hrs.

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

Unit V Sound Scattering and Radiation 12 Hrs.

Scattering at rough boundary surfaces; Method of small perturbation (MSP); Scattering of sound by surface waves and internal waves. Generation of sound by marine vehicles and offshore platforms. Application: Remote sensing; Underwater communication; Sonar principle and use; Acoustic tomography; Geophysical seismic exploration

Reference Books

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.

	Ocean Renewable Energy	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objectives: In the world's present scenario, there is a need for exploringalternative 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 10 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, tidalrange: lagoons and barrages.

Unit III Offshore Wind Energy 12 Hrs.

Introduction and history of offshore wind energy, offshore wind turbines, aerodynamicsof 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 10 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 10 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 TidalEnergy, 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.

Program Elective II	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Composite Boat design and Construction	PE	3	0	0	3	3
Traditional Boat Building Techniques	PE	3	0	0	3	3
Fishing Vessel Technology	PE	3	0	0	3	3
Submarine and Submersibles	PE	3	0	0	3	3

	Composite Boat design and Construction	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To introduce the boat building techniques using compositematerials

Unit I Introduction to composite materials 12 Hrs.

History of fibre reinforced composites, Constituent materials– Fibres, matrix, fillers, additives, Properties of typical composite materials, Application of composites Processing FRP composites: Molding – Spray up, hand lay-up, Compression moulding – matched dies moulding, Forming methods employing gas pressure, low pressure closed moulding, Pultrusion, Filament winding

Unit II FRP boat construction 12 Hrs.

Single skin, sandwich construction, Types of frames (Top hat, with or without core), Bulkhead, Typical midship section of FRP boat, Connections – Hull to deck, bulkhead to hull, Hull moulding, Composite propellers, Deck moulding-Environmental control,temperature and humidity control.

Unit III Micro mechanical analysis 12 Hrs.

Volume and weight fractions, Longitudinal strength and stiffness, Transverse section modulus, Shear modulus, Poisson‘s ratio. Structural Analysis: Elastic properties of unidirectional lamina, Stress strain relationships, Analysis of laminated composites, Basic assumptions, stress- displacement / stress-strain relationship, coupling effect, Types of laminate configuration (symmetric, anti-symmetric)

Unit IV Structural design of FRP boats 09 Hrs.

Basic structural arrangement using classification society rules, Determination of boat shell lamination using classification society rules, Determination of stiffener laminationand size using classification society rules.

Unit V FRP boat construction quality control 09 Hrs.

Destructive testing, Non-destructive testing (Ultrasonic, Infraredthermograph, laser shearography)

Text Books:

1. JONES, R.M., (1998), Mechanics of Composite Materials. Technology and Engineering.
2. MUKHOPADHYAY, M., (2005), *Mechanics of composite materials and structures*. Universities press.

Reference Books:

1. Indian Register of Shipping. Rules and regulations for the construction and classification of high speed crafts and light crafts, 2016.
2. GREENE, E., (2014), Marine composites non-destructive evaluation. *Ship Structure*, *1*, pp.416-427.
3. CHAWLA, K.K., (2012), *Composite materials: science and engineering*. Springer Science & Business Media.

	Traditional Boat BuildingTechniques	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: Introduce students to the boat building techniques of history

Unit I Traditional Boats 12 Hrs.

History/Background, Construction techniques, Designers plans, Building moulds, jigsand strong-backs

Wooden kit boats, Skills required, Different types of wood/timber used in boat building

Regional boats of India and other countries – Snake boats, house boats, Urus ofMalabar, Kerala, Dhows of Mandvi, Gujarat, Teppas of Ganjam, Orissa, Boats ofZanzibar, Iran, UK and Hong Kong.

Unit II Build Management 09 Hrs.

Yard selection, Workshop/Yard requirements, Budgeting and Costs, Project Management, Sourcing Parts, Buy or Lease/machinery and tools, BOM's/detailed costs

Unit III Outfitting 12 Hrs.

Internal Layouts, Electrical Systems, Water & Sanitation Systems, Safety Equipment & Navigation Systems, Anchoring, mooring & Deck fittings, Painting the boat

Unit IV Documentation 09 Hrs.

CE Certification, Type Approval/Licensing, Legal Requirements, VAT/ Goods Service Taxetc, Warranties/Manuals, Basic Safety at Sea, Skills required & sub-contracting, Insurance, Inland Waterway Regulations.

Unit V Finish and Launch 12 Hrs.

Boat relocation, Launching, Ways of lifting & launching a vessel, The actual launch,Stepping the mast, Types of berth/moorings, Sea Trials, Modifications

Text and Reference Books:

1. LEVENSON, E., (2013), Traditional Boat Building: An Intersection of Zanzibar's Culture and Environment.
2. McKEE, E., (1976), Traditional British Boat building Methods. *The Mariner's Mirror*, *62*(1), pp.3-14.
3. VARADARAJAN, L., (1993), Indian boat building traditions. The ethnological evidence. *Topoi. Orient-Occident*, *3*(2), pp.547-568.

	Fishing Vessel Technology	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To understand the processes involved in designing 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 - fisheriesorganizations 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 and 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 09 Hrs.

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

Unit IV Construction methods 09 Hrs.

Material and construction methods - mechanical properties of materials - comparison ofhulls of different material - type of construction - details of steel construction - construction methods in FRP/GRP, Aluminum, 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, positionfixing 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 Handbook, International Marine/Ragged Mountain Press.
4. LARS LARSSON and 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.

	Submarines and Submersibles	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objectives: To expose the student about the knowledge of Submarineand Submersibles

Unit I Introduction 12 Hrs.

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

Unit II Submarine hydrostatics 12 Hrs.

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 Hrs.

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 10 Hrs.

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 08 Hrs.

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 SystemsDesigns '' 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.

Semester VII

Course Code	Course	Category	L	T	P	C	Hrs/ week
	Marine Power Plant	PC	3	0	0	3	3
	Marine Survey and Certification	PC	3	0	0	3	3
	Occupational Health and Safety	HS	3	0	0	3	3
	Humanities Elective I	HE	3	0	0	3	3
	Program Elective III	PE	3	0	0	3	3
	Program Elective IV	PE	3	0	0	3	3
	Ship Design Project	PW	0	0	10	5	10
	Shipyard Visit/Industrial Training*	MC	0	0	1	0	1
	Total		**18**	**0**	**11**	**23**	**29**

*Total 15/18 hours of shipyard visit in the semester. Translating to 1 hour per week

Humanities Elective I	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week.**
Entrepreneurship Development and IPR	HE	3	0	0	3	3
Introduction to Operations Research	HE	3	0	0	3	3
Planning for Sustainable Development	HE	3	0	0	3	3
Business Fundamentals and Economics	HE	3	0	0	3	3
Program Elective III	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week.**
Computer Aided Design and Manufacturing	PE	3	0	0	3	3
Marine Computational Fluid Dynamics	PE	3	0	0	3	3
Finite Element Method	PE	3	0	0	3	3
Instrumentation and Control Systems	PE	3	0	0	3	3
Program Elective IV	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Autonomous Vehicles	PE	3	0	0	3	3
Design of Offshore Structures	PE	3	0	0	3	3

Inland Water Transportation	PE	3	0	0	3	3
Industry 4.0	PE	3	0	0	3	3

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

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

Unit I Energy Conversion and 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 - shipsystems 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 and propulsors - propulsion support systems. Types of drives- Direct drive - geared drive - Drives involving steam and gas turbines as primemovers - combined drives with single or multiple shaft lines - Diesel Electric Propulsionand all electric ship concepts - electric drive application in submarines - Hybrid drives -redundancy - engine room layout and machinery arrangement.

Unit II Electric Power Generation and Distribution 13 Hrs.

Main components of electric power plant - Electric power Demand and Load analysis -simulation of electric power demand - Emergency power estimation. Installation rulesfor electrical power plant-Choices for emergency power plant - Location of emergencypower source. Main Components of electrical systems 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 asprime movers- shaft driven generators, Earthed or unearthed systems - three or 4 wire systems - DC systems- Components of distribution systems. 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 oftransformers. Cables-testing of cables –Megger.

Unit III Diesel engines and 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 and efficiency - limitations. Thermodynamics of Gas turbines- Brayton Cycle - work and heat - power density and efficiency.

Unit IV Engine selection and Propeller Matching 09 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 ofgear ratio and pitch - Change in PTO operating condition.

Unit V Ship Fuel Consumption and emissions 06 Hrs.

Energy Balance for a Ship - Fuel Consumption Ton–Mile considerations, Range and Endurance - Health and Environmental Significance of combustion products - Measurement and quantification of exhaust emissions-NOx Technical code -ISO8718. Exhaust emissions from shipping and their control measures - SOLAS and MARPOL regulations and Energy Efficiency Design Index (EEDI).

References:

1. Bulk Carriers – Guidelines for Surveys, Assessment and Repair of Hull Structures; Witherby seamanship International 2017
2. Norman Millard ; Lloyds Survey handbook; LP Professional Publishing; 7th Revised edition 1999
3. Huibert, Jan Lekkerkerk; GNSS Survey and Engineering: Handbook for Surveyors and Survey Engineers; The Nautical mind 2017
4. Don Butler A Guide to Ship Repair Estimates in Man-hours, Butterworth-Heinemann ,2012.
5. SOLAS latest edition
6. MS Act
7. Class rule books.
8. IACS requirements for Survey and Certification.
9. Introduction to Naval Arch – Eric Tupper Edn 5

	Marine Survey and Certification	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: This course provides students a general idea about Marine surveying and Certification activities carried out and also students will be ableto explain activities of statutory bodies and other agencies involved in surveying.

Unit I Marine Surveys 09 Hrs.

Need of Marine survey and certification – safety, pollution, commercial requirements. UNCLOS and legal framework on survey. IMO, National bodies, flag state, classification societies, IACS. Regulations, Unified interpretations. Standards. Impactof rules and regulations on ship design.Various types of marine surveys – statutory, Class, Third party. Roles and responsibilities of marine surveying agencies. Activities of classification societies and surveying agencies bodies Classification society
– Design approval, construction survey, survey on operation, repair conversion. Industrial surveys, third party accreditation

Unit II Statutory surveys and certifications 12 Hrs.

Statutory surveys for different type of vessels- passenger ships, cargo ships, other vessels, offshore installations. Different types of Surveys – Building survey, Initial, Annual, Periodical, intermediate, renewal, special. SAFCON, SEQ, SR, Load line, Tonnage, IOPP, SMC, MLC, ISPS, Special type ship surveys. Items to be surveyed, Methodology of survey. Harmonized system of survey and Certification. Enhanced survey (ESP). Maintenance of conditions after survey, certificate forms and itsendorsements, duration, validity and control. Who conducts the survey-authority, responsibility

Unit III Classification Surveys 12 Hrs.

Need to be in class, Class activities: Design approval, construction survey, survey on operation, repair and conversion, Industrial surveys, third party accreditation. Inspection and auditing. Certificate of Class. Class survey items, Hull and Machinery surveys, cargo gear, ship products inspection and certification. Items to be surveyed, Methodology of survey. Structural survey, close up, visual, operational, thickness measurements. Condition of class.

Unit IV Survey 09 Hrs.

Schedule, Scope, Preparation for survey, areas and components to be to be inspected access to structures, Equipment for surveys, survey at sea, anchorage, berth. Coating condition. Pitting, corrosion, Reports, findings, documentations, survey report file, underwater survey, remote survey, Result of survey, Hull survey, Machinery survey: PMS, Tail shaft, statutory survey, Damage survey, Repair survey, docking survey. Cargo survey, draft survey

Unit V Inspection and Certification 12 Hrs.

Activities of statutory bodies –DGS, MMD, Port state control. Information of Relevant regulations of MS Act for survey and certification, Registry. Flag of convenience.
Inspectorate of boats – design approval; construction inclination experiment, keel sighting, registration, surveys during – repair conversion and operation.
Activities of other bodies – port authority, IWAI, Local bodies, canals etc.
Warship construction warship overseeing team, inspection during construction; lineout inspection;
Introduction of Marine Insurance, PandI, Marine Cargo Survey, Survey dry, liquid and container, cargoes.

References:

10. Bulk Carriers – Guidelines for Surveys, Assessment and Repair of Hull Structures; Witherby seamanship International 2017
11. Norman Millard ; Lloyds Survey handbook; LP Professional Publishing; 7th Revised edition 1999
12. Huibert, Jan Lekkerkerk; GNSS Survey and Engineering: Handbook for Surveyors and Survey Engineers; The Nautical mind 2017
13. Don Butler A Guide to Ship Repair Estimates in Man-hours, Butterworth-Heinemann ,2012.
14. SOLAS latest edition
15. MS Act
16. Class rule books.
17. IACS requirements for Survey and Certification.
18. Introduction to Naval Arch – Eric Tupper Edn 5

	Occupational Safety and Health	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To make students understand industrial safety, safe working practices, safety management, first aid and Fire prevention with a specialfocus on Marine industry. Students can learn scaffolding and its applicationin industry.

Unit I General safety 11 Hrs.

Housekeeping, Identification of hazards, Safety signs, Tool box Meeting, Safety Handbook, Safety data-sheet and its management system, Vessel Safety Coordination Committee (VSCC), Composition and meetings, Duties of Chairman and Secretary, Authorization of hazardous work.
Permit to Work (PTW) System, Procedure. Mechanical Hazards, Machine safety - guarding of common hand tools and machines, e.g. hand grinder, metal disc cutter, portable ventilators. Lock-Out Tag Out (LOTO) of ships facilities (including blanking ofpipelines and isolation of ships fire-fighting system)
Duties and responsibilities of a safety officer, Health and safety department and HSEorganization. safety inspections, Inspection checklist and reports.

Unit II Safe working Practices 12 Hrs.

Safety with Enclosed Space: Common hazards in confined space, Oxygen deficiency and oxygen enrichment, Ventilation for confined space, Provision of PPE, Testing of atmosphere, Safe entry permits, Emergency.

Hot work Safety: Causes of fire and explosions, · Hot work permit system, Types of hot works, · Cutting, burning and welding, · Gas cutting and welding, Electrical arc welding, Grinding, · Risk of hot-work in partially cleaned tanks .

Electrical safety: Relevant Safety standard and Code of Procedures , Basic principles of electricity, Causes of electrical accidents, Electrical injuries, · Earthing, · Using safe and low voltage, Typical shock hazards, · Preventive maintenance and preventive measures - Use of low voltage shock prevention (LVSP), non-sparking tools, flame-proof electrical equipment and lighting

High pressure water jetting or steam cleaning Safety: Shot blasting, grit blasting andchipping, Spray painting - use of flameproof lights and equipment.
Safety with Lifting, Crane, Forklift, Manual Handling: Crane operations and lifting equipment, Manual handling, Manual lifting, Conditions of materials, Manual

handlingregulations, Mechanical handling

Safety with Heights: Falling from height hazards, Falling object hazards, Safety programme for working at height, Scaffolding and staging, Permit to Work

Unit III Management, Legislation, Investigation 09 Hrs.

Risk management Process: Hazard Identification, Risk Assessment and Management(HIRA), Hierarchy of Controls and Preventive Measures for work activities, Effective Communication on HIRA and Preventive Measures

Legislation on Occupational Health: Workplace safety Health regulations on - GeneralProvisions, Abrasive Blasting, Noise, Medical Examination, Asbestos.
Workplace safety Health regulations on Hazards : – Noise, Vibration, Heat, Radiation and lighting (including protection for general, general lighting to prevent breakage oflight bulbs, – Basic industrial toxicology, Safety data sheet (SDS)

Workplace safety Health regulations on Processes: Spray painting, Welding, Abrasiveblasting, Asbestos work, – Tank cleaning (including Hazards during chemical cleaning), – System pressure testing, Radiography,

Accident Investigation : Definition of accident, Accident causation, Principles of accident prevention, Accident investigation and Investigator, Procedure and Report. Case studies.

Unit IV First Aid and Fire Prevention 12 Hrs.

First Aid : General Principals, Body Structure, Functions, Positioning of Causality, Unconscious causality, Resuscitation, ABC, CPR. Bleeding, Management of Shock, Burns, Scalds, Electric Shock. Rescue and Transport of Causality from different spaces including enclosed spaces. Bandaging, Infectious diseases, Personal hygiene.

Fire Prevention and Fire Fighting: Theory of Fire, Fire Prevention, Fire Detection, Extinguishing, Fire fighting Equipments, Fire Fighting Organisation, Methods, Fire Fighting Procedures, Fire Fighting drills.
(Practical Sessions on First Aid and FPFF)

Unit V Scaffolding 10 Hrs.

Scaffolding and its uses in industry. Types of Scaffolds: System, Tube and Coupler, Mobile and Tower, bracket, under hung, Scaffold: Capacity, Foundation, stability. Scaffolding Components, Scaffolding terms , Definitions.

Hazards related to elevated Work platforms, Requirements : Fall protection, Guard rails, fall arrestor, Systems, falling objects, entry/ exit, slip and Trips, Roof work, lighting, high wind, work over water, Hot surfaces.

Define, Duties, responsibilities: competent person, Qualified person, authorized person, Scaffold Accidents Reasons and its prevention, Mobile Elevated Platforms: Safety Hazards, Risk Control.

Safety Code for Scaffolds and Ladders – Indian Standards (BIS)

Practical on above and Constructing various types of Scaffolding and Working on them.

Reference Books

1. Code of Safe working Practices - MCA –UK
2. Scaffolding Safety Hand Book – Saudi ARAMCO
3. SAFETY Standards for Saffolds and Ladders – Bureau of Indian Standards, IS 3696.

Humanities Elective I	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Entrepreneurship Development and IPR	HE	3	0	0	3	3
Introduction to Operations Research	HE	3	0	0	3	3
Planning for Sustainable Development	HE	3	0	0	3	3
Business Fundamentals and Economics	HE	3	0	0	3	3

	Entrepreneurship Developmentand IPR	L	T	P	C	Hrs/ sem
		3	0	0	3	54

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

Unit I Entrepreneurship 09 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 09 Hrs.

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

Unit III Business 09 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 and Pattern

Unit IV Financing and Accounting 09 Hrs.

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 09 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 09 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 and Co. Ltd. Ram Nagar New Delhi.
2. KURAHKO and HODGETTS, Entrepreneurship – Theory, process and practices, Thomson learning 6th edition.
3. WADHERA (2004), Intellectual Property Rights, Universal Law Publishing Co.

Reference Books:

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 and Allied Rights, Sweet and 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 OperationsResearch	L	T	P	C	Hrs/ sem
		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 and Queuing problems.

Unit V Project Management and Replacement Models 12 Hrs.

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM andPERT 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, 2nd edition 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 and Co.

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

Objective: To make students understand the importance of sustainability anduse them in engineering and development

Unit I Principles and Evolution of Sustainable development 12 Hrs.

Explain and critically evaluates the concept of sustainable development, Environmental degradation and poverty Sustainable development: its main principles, the evolution ofideas 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 II Environmental management 12 Hrs.

Innovation for sustainable development- Environmental management and innovation strategies.

Unit III Societal transformations 12 Hrs.

Societal transformations. Institutional theory.

Unit IV Governance 09 Hrs.

Governance for sustainable development. Policy responses to environmental degradation.

Unit V Research and development 09 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 Approach, 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.

	Business Fundamentals and Economics	L	T	P	C	Hrs/ sem
		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 conceptslike 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 09 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 MonetaryFund - 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 06 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 III	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week**
Computer Aided Design and Manufacturing	PE	3	0	0	3	3
Marine Computational Fluid Dynamics	PE	3	0	0	3	3
Introduction to Finite Element Method	PE	3	0	0	3	3
Instrumentation and Control Systems	PE	3	0	0	3	3

	Computer Aided Design and Manufacturing	L	T	P	C	Hrs/ sem
		3	0	0	3	54

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

Unit I Computer Aided Design (CAD) 09 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) 09 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 and 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 and Programming, 4th Edition, Delmar Thomson Learning Inc.
3. FRANCO. PREPARATIONS, (1985), Computational Geometry, Springer.
4. GROOVER .MIKELL P, (1984), Computer Aided Design and Manufacturing, Prentice -Hall of India (P) Ltd.

	Marine Computational Fluid Dynamics	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To provide an insight into the numerical aspects of Fluid Dynamics

Unit I **Introduction to Computational Fluid Dynamics and Principles of Conservation** **10 Hrs.**

CFD Applications, Numerical vs Analytical vs Experimental, Modelling vs Experimentation; Fundamental principles of conservation, Reynolds transport theorem, Conservation equations: mass; momentum and energy equations; convective forms ofthe equations and general description

Unit II **Numerical Methods for Solving CFD Problems** **10 Hrs.**

Classification and Overview of Numerical Methods: Classification into various types of equations; parabolic, elliptic and hyperbolic; boundary and initial conditions; overview of numerical methods: Finite Difference Method, Finite Element Method and Finite Volume Method.

Unit III **Implementing a CFD Code** **10 Hrs.**

The basic structure of a CFD code: Pre-processor, Solver and Postprocessor, User-defined subroutines;

Grid generation: Numerical grid generation, basic ideas, transformation and mapping;Solution to some basic problems in fluid flow – free surface flows and N-S equations around a body in water; Numerical flow simulation.

Unit IV **Turbulence Modeling** **10 Hrs.**

Important features of turbulent flow, Vorticity transport equation, General Properties of turbulent quantities, Reynolds Average Navier Stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling, Different types of turbulencemodel: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, More two-equation models: RNG κ-ε model and κ-ω model, Reynolds Stress Model (RSM), Large Eddy Simulation (LES), Direct Numerical Simulation (DNS)

Unit V **Minor Project** **14 Hrs.**

A minor project in CFD applications to Ship Hydrodynamics using any commercial or open-source CFD package. May include programming exercise to solve problems and analyze the results.

Text Books

1. ANDERSON, J.D. and WENDT, J., (1995), *Computational fluid dynamics* (Vol. 206, p. 332). New York: McGraw-Hill.
2. CHUNG T.J.,(2016) Computational Fluid Dynamics, Cambridge University Press.
3. VERSTEEG, H.K. and MALASEKERA, W., (2007), *An introduction to computational fluid dynamics: the finite volume method*. Pearson education.

Reference Books

1. FERZIGER, J.H., PERIC, M. and Street, R.L., (2002), *Computational methods for fluid dynamics* (Vol. 3, pp. 196-200). Berlin: springer.
2. HIRSCH, C., (2007), *Numerical computation of internal and external flows: The fundamentals of computational fluid dynamics*. Elsevier.

	Introduction to Finite Element Method	L	T	P	C	Hrs/ sem
		3	0	0	3	54

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

Unit I **Fundamental concepts** **09 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, Coordinates and shape functions, The potential-energy approach, The Galerkin approach, Assembly of global stiffness matrixand load vector, Properties of global stiffness matrix, Types of boundary conditions, Simple problems in plane truss 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, elementforce vectors, Axisymmetric solids subjected to axisymmetric loading: example case of cylinder subjected to internal pressure.

Unit IV **Three dimensional analysis** **09 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 andeigenvector evaluation and their properties.

Text Books

1. TIRUPATHI R, CHANDRUPATLA ASHOK, BELEGUNDU D., (2014),
2. Introduction to finite Elements in Engineering, Pearson Education.
3. 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.

	Instrumentation and Control Systems	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: Familiarize with basic principles and characteristics of measuringinstruments

Unit I Fundamentals of Measurement Systems 09 Hrs.

Fundamentals of Measurement Systems, Instrument Types and Performance Characteristics, sources of error, classification and elimination of error, uncertainty analysis- statistical analysis of experimental data, curve fitting.
Signal conditioning, amplifiers, and filter, Wheatstone bridge, Analog to Digital and Digital to Analog Circuits.

Unit II Basic Measurements 12 Hrs.

Pressure Measurement: Elastic transducers, Bourdon gauge, Bellows, Diaphragm. Flow measurement: Turbine meter, hot-wire anemometer and Laser Doppler Anemometer. Level Measurement: Float gauge, Capacitive and ultrasonic level sensors.

Unit III Fundamentals of Control Systems 12 Hrs.

Introduction to control systems – open and closed loop control systems – Modeling ofsimple mechanical and electrical systems – transfer functions – block diagrams and its reduction techniques, signal flow graphs.

Unit IV Time and Frequency Response Analysis 12 Hrs.

Time response characteristics of control systems – Time response of first order systems – response to step, ramp and impulse – Time response of second order system to step input – time domain specifications and steady state error
Stability analysis of control systems- concept of poles and zeros- Routh Hurwitz criterion- simple examples- root locus technique
Frequency Response- Frequency Response specifications, Bode diagram, Polar Plot and Nyquist Plot, Stability analysis using Nyquist Stability Criterion, Relative stability, Gain and Phase Margin. Lag-Lead Compensation, Control systems analysis and designin state space

Unit V Stability Analysis and Basic Control Actions 09 Hrs.

Stability analysis of control systems- concept of poles and zeros- Routh Hurwitz criterion- simple examples- root locus technique.
Basic control actions: Introduction to PI, PD and PID controllers, Design of a PID controller with Ziegler-Nichols rule

Textbooks

1. DOEBELIN'S E.O., and MANIK D.N., "Doebelin's Measurement Systems", 6th Edition,McGraw Hill Education, 2011

2. KATSUHIKO OGATA, "Modern Control Engineering", 5th Edition, Pearson Education,New Delhi, 2010

Reference books

1. JOHN P. BENTLEY, "Principles of Measurement Systems", 4th Edition, PearsonEducation, New Delhi, 2005

2. RICHARD C. DORF and ROBERT H. BISHOP, "Modern Control Systems", 12th Edition,Pearson Education, New Delhi, 2011

3. NORMAN S. NISE, "Control Systems Engineering", 7th Edition, John Wiley & Sons, NewDelhi, 2015

Program Elective IV	**Category**	**L**	**T**	**P**	**C**	**Hrs/ week.**
AI and Automation	PE	3	0	0	3	3
Design of Offshore Structures	PE	3	0	0	3	3
Inland Water Transportation	PE	3	0	0	3	3
Industry 4.0	PE	3	0	0	3	3

	AI and Automation	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To make students understand automation, and control systems inmarine industry. Students to develop knowledge in basics of CNC machines, robotics with applications related to shipbuilding.

Unit I Basics of Automation and Control 09 Hrs.

Brief introduction about industrial processes and their automation; Elements of pneumatic, hydraulic and electrical control systems; Valves and actuators; Stepper motors; PID controllers and their tuning;

Unit II Introduction to Industrial Control Systems 09 Hrs.

Implementation of digital controller; Control strategies for industrial processes; Programmable logic controller; Real-time issues on signal transmission and control; Communication systems for industrial automation; Data acquisition and supervisory control; Control of discrete manufacturing processes; Intelligent systems for monitoring, supervision and control; Case studies of industrial control systems.

Unit III Principles of Numerical Control and Coding 12 Hrs.

Basic principles of automation; Extending the capabilities of conventional machines through improved devices and manipulators; Basic principles of numerical control; CNC, DNC and Machining Centres; Methods of coding and programming; APT programming; Adaptive control; Economics of numerical control.

Unit IV Introduction to Robotics 12 Hrs.

Introduction to Robotics: Synthesis of elements with movability constraints; Elementsof robot anatomy; Hydraulic, pneumatic and electrical manipulators; End-effectors and their design; Controllers with microprocessors or fluidics; Robot Sensors; Applications of industrial robots; Economics of robotics

Unit V Automation in Marine Industry 12 Hrs.

Concepts in manufacturing and automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation in shipbuilding. Digital Shipyards, Robots in welding, blasting, heavy lifting and other tasks.

Reference Books

1. J.J.CRAIG, (1991), Introduction to Robotics, Addison-Wesley
2. Y.KOREN, (1985), Robotics for engineers, McGraw-Hill
3. S.R.DEB, (2010), Robotics Technology and Flexible Automation, TMH
4. N.K.TEWARI, KUNDRA, P.N.RAO, (1998), Computer Aided Manufacturing, McGraw-Hill
5. R BOEKHOLT, (1996), Welding Mechanisation and Automation in Shipbuilding Worldwide, Elsevier

	Design of Offshore Structures	L	T	P	C	Hrs/ sem
		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 JointProbability 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. 06 Hrs.

Simpletubular 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 uplegs

Unit V Design against Accidental Loads 12 Hrs.

(Fire, Blast and Collision): Behavior 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 DesignConstruction 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), *OffshoreStructures Vol I & II*, Springer Publications.
4. SRINIVASAN CHANDRASEKAR, (2015), *Dynamic Analysis & Design ofOff Shore Structures,* Springer Publishers.

	Inland Water Transportation	L	T	P	C	Hrs/ sem
		3	0	0	3	54

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

Unit I Introduction 06 Hrs.

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 12 Hrs.

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 12 Hrs.

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

Unit IV Hull shapes of inland vessels 15 Hrs.

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 09 Hrs.

Cargo handling and 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, Inlandand Maritime waterways and ports -Design Construction and Operation Pergamon Press.
2. United Nations, 2003,'' Manual on Modernization of Inland water Transportfor 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 and Prospects, Routledge.
4. International Navigation Association, 1885, Guidelines for sustainable Inland Waterways and Navigation, PIANC

	Industry 4.0	L	T	P	C	Hrs/ sem
		3	0	0	3	54

Objective: To introduce students to the recent industrial revolution and its requirements in shipping

Unit I Introduction and Conceptual Framework 12 Hrs.

Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

Unit II Roadmap for Industry 4.0 09 Hrs.

Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

Unit III Advances in Robotics 12 Hrs.

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

Unit IV Advances in Digitalization 12 Hrs.

Introduction, AR Hardware and Software Technology, Industrial Applications of AR. The concept of digital twin-its prospects in maritime industry, Artificial Intelligence, IOT.

Unit V Obstacles 09 Hrs.

Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data

Text Books:

1. USTUNDAG, A. and CEVIKCAN, E., (2018), *Industry 4.0: managing the digital transformation*. by Springer Nature.
2. BARTODZIEJ, C.J. and BARTODZIEJ, C.J., (2017), *The concept industry 4.0* (pp. 27-50). Springer Fachmedien Wiesbaden.

Reference Books:

1. SCHRODER, C., (2016), The challenges of industry 4.0 for small and medium-sized enterprises. *Friedrich-Ebert-Stiftung: Bonn, Germany*.

Semester VIII

Subject Code	Subject	Category	L	T	P	C	Hrs/ week
	Micro Credit Course - I	MCC	1	0	0	1	1
	Micro Credit Course - II	MCC	1	0	0	1	1
	Micro Credit Course - III /Special Topic Course-I	SP	1	0	0	1	1
	Micro Credit Course - IV /Special Topic Course-II	SP	1	0	0	1	1
	Project Work, Seminar and Viva Voce	PW	0	0	16	8	16
	Comprehensive Viva-Voce	PW	0	0	0	5	0
	Total		**4**	**0**	**16**	**17**	**20**

		L	T	P	C	Hrs/ sem
	Micro Credit Course / Special TopicCourses	**1**	**0**	**0**	**1**	**18**

	Micro Credit Course - I
	Micro Credit Course - II
	Micro Credit Course - III /Special Topic Course-I
	Micro Credit Course - IV /Special Topic Course-II

Micro Credit Course are to be selected by students from the list available for other schools or courses

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/ sem**
		0	**0**	**16**	**8**	**288**

Students have to do a group project specializing in any area of the entire course work carried out under the Department of Naval Architecture and Ship Building. Students shall submit a Project report to the satisfaction of the department. Each Student in the group has to give a seminar talk onsome of the aspects of the project and appear for Viva Voce.

		L	T	P	C	Hrs/ sem
	Comprehensive Viva- Voce	**0**	**0**	**0**	**5**	**0**

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