Course code	Course Name	L-T-P-Credits	Year of Introduction
CE336	STRENGTH OF MATERIALS LAB	0-0-3-1	2016

Prerequisite : SB201 Mechanics of solids

Course Objectives:

- To study various types of failures occurring in service life of ductile metals.
- Provide an environment to enable students to correlate theoretical knowledge gained in the class room with the physical world.
- To study the properties of various materials under various working conditions.

List of Exercises/ Experiments (Minimum 12 Mandatory)

1. Tests on Open Coiled Spring
   Equipment: Spring Testing Machine, Vernier Calliper.
2. Tests on Closed Coiled Spring
   Equipment: Spring Testing Machine, Vernier Calliper.
3. Bending Test on Wooden Beams Using U. T. M.
   Equipment: Universal Testing Machine, Deflection Gauges, Measuring Tape.
4. Verification of Clerk Maxwell's Law of Reciprocal Deflection and Determination of Young's Modulus 'E' for Steel.
   Equipment: Apparatus for verification of Clerk Maxwell's Law of Reciprocal Theorem, Deflection gauges, Weights, Scale, Vernier Calliper.
5. Torsion Pendulum Test for M.S. wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
6. Torsion Pendulum Test for Aluminium Wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
7. Torsion Pendulum Test for Brass Wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
8. Tension Test Using U. T. M. on M. S. Rod.
   Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
9. Tension Test Using U. T. M. on Torsteel rod
   Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
10. Tension Test Using U. T. M. on High Tensile Steel rod.
    Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
11. Compression test on concrete specimen.
    Equipment: Compression Testing Machine.
12. Compression test on brick.
    Equipment: Compression Testing Machine.
13. Torsion Test on M. S. Rod.
    Equipment: Torsion Testing Machine, Vernier Caliper.
14. Shear Test on M.S. Rod.
    Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
15. Impact Test Using Izod Apparatus and Charpy.
    Equipment: Charpy/ Izod Impact Testing Machine.
16. Impact Test Using Charpy Apparatus
    Equipment: Charpy/ Izod Impact Testing Machine.

17. Hardness Test using Brinell Hardness Apparatus
    Equipment: *Brinell Hardness Testing Machine.*
18. Strut Test.
    Equipment: *Strut Testing Machine, Vernier Calliper.*

Course Outcome:

Upon successful completion of the course, the student will be:

i. Familiar with the arrangement and conduct of experiments in the Material Testing laboratory environment.
ii. Able to note down relevant readings and perform calculations while an experiment is in progress thereby correlating theoretical concepts of materials and their practical implications..
iii. Able to comprehend the factors responsible for variation between theoretical and experimental results pertaining to the domain of Material Science.

Text books:

1. R.K. Bansal; Strength of Materials; Laxmi Publications.
2. Wonsiri Punurai; Mechanics of Materials-Laboratory and Experiments; LAP LAMBERT Academic Publishing.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
EE339	ELECTRICAL ENGINEERING LAB	0-0-3-1	2016

Prerequisite : EE214 Electrical technology and instrumentation

Course Objectives:

- Introduction to devices commonly used in carrying out experiments pertaining to the domain of electrical engineering.
- Familiarization in setting up of experiments in a laboratory environment.
- To carryout load test on various electrical machinery and evaluate their performance.
- Provide an environment to correlate theoretical knowledge gained in the class room with the physical world.

List of Exercises/ Experiments (Minimum 12 experiments/exercises are mandatory)

1. Study of 3-point and 4-point starters for D.C machines
   Equipment: 3 Point Starter, 4 Point Starter.

2. OCC of self excited D.C machines – critical resistances of various speeds. Voltage built-up with a given field circuit resistance. Critical speed for a given field circuit resistance.
   Equipment: D.C Motor-Generator set, Ammeter, Voltmeter, Rheostat.

3. OCC of separately excited D.C machines.
   Equipment: D.C Motor-Generator Set, Ammeter, Voltmeter, Rheostat.

4. Load test on shunt generator – deduce external, internal and armature characteristics.
   Equipment: D.C Shunt Generator- Motor Set, Ammeter, Voltmeter, Rheostat, Loading Rheostat.

5. Load test on compound generator.
   Equipment: Compound Generator, Ammeter, Voltmeter, Rheostat, Loading Rheostat.

6. Swinburne's test on D.C machines.
   Equipment: D.C Shunt Motor, Ammeter, Voltmeter, Rheostat.

7. Brake test on D.C shunt motors and determination of characteristics.
   Equipment: D.C Shunt Motor, Ammeter, Voltmeter, Rheostat.

8. Brake test on D.C series motors and determination of characteristics.
   Equipment: D.C Series Motor, Ammeter, Voltmeter.

9. Brake test on D.C compound motors and determination of characteristics.
   Equipment: D.C Compound Motor, Ammeter, Voltmeter, Rheostat.

10. O.C and S.C tests on single phase transformers – calculation of performance using

equivalent circuit – efficiency, regulation at unity, lagging and leading power factors.
Equipment: Single Phase Transformer, Ammeter, Voltmeter, Wattmeter, Autotransformer.

11. Load test on single phase transformers.
Equipment: Single Phase Transformer Ammeter, Voltmeter, Wattmeter, Loading Rheostat

12. Alternator regulation by emf and mmf methods.
Equipment: Alternator Set, Ammeter, Voltmeter, Rheostat.

13. Study of starters for three phase induction motors.
Equipment: Star Delta Starter, TPDT switch, Autotransformer.

14. Load tests on three phase squirrel cage induction motors.
Equipment: 3 Phase Squirrel Cage Induction Motor, Ammeter, Voltmeter, Wattmeter.

15. Load tests on three phase slip ring induction motors.
Equipment: 3 Phase Slip Ring Induction Motor, Ammeter, Voltmeter, Wattmeter.

16. Load tests on single phase induction motors.
Equipment: Single Phase Induction Motor, Ammeter, Voltmeter, Wattmeter.

17. Polarity, transformation ratio of single phase transformer.
Equipment: Single Phase Transformer, Ammeter, Voltmeter.

18. Equivalent circuit of three phase squirrel cage induction motor.
Equipment: 3 Phase Squirrel Cage Induction Motor, Ammeter, Voltmeter, Wattmeter.

Course Outcome:

Upon successful completion of the course, the student will be:

i. Familiar with the arrangement and conduct of experiments in an electrical laboratory environment.
ii. Able to note down relevant readings and perform calculations while an electrical experiment is in progress.
iii. Able to comprehend the factors responsible for variation between theoretical and experimental results.

Text Book:

- J. B. Gupta; Theory and Performance of Electrical Machines; S.K. Kataria & Sons.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB301	SHIP DYNAMICS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives:

- To familiarise the use of linear wave theory in representation of ocean waves.
- To interpret the use of Strip theory in theoretical study of sea keeping.
- To perceive the effect of waves on ships and resultant effects or motions.
- To formulate methods to control ship response in sea during design and operation.
- To understand the forces on a ship in a turn and the effect of the ship characteristics and rudder on turning ability.
- To evaluate dynamic effects of High Speed Craft in motion.

Syllabus:

Introduction to Sea-Keeping of ships, Ocean Waves and Ships, Ship in Seaway and Dynamic effects, Ship Motion Control, Maneuvering Fundamentals, Control Surface Design, Experimental Determination of Hydrodynamic Derivatives, Model Tests, Various Types of Trials, Ship Dynamics and Design Aspects, Performance Criteria, Sea keeping Features of High Performance Ships, Effect of Hull Configuration in Maneuvering Ability.

Expected Outcome:

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

i. Theoretically analyse sea keeping and maneuvering behaviour of ships.
ii. Predict performance of ship in various wave conditions and compare it with design criteria and regulatory body guidelines.
iii. Compare Hydrodynamic behavior of different ships in consideration.

Text Books:

1. Lewis E.U; Principles of Naval Architecture (2nd Revision) Vol. III 1989; SNAME, New York.
2. Bhattacharya. R, Dynamics of Marine vehicles, Wiley Inter Science, New York, 1978.

Reference Books:

1. A. R. J. M. Lloyd; Sea keeping: Ship Behaviour in Rough Weather; John Wiley & Sons.
2. Anthony F. Molland and Stephen R. Turnock; Marine Rudders and Control Surfaces - Principles, Data, Design and Applications, 2007; Butterworth-Heinemann.
3. Edward M. Lewandowski; The Dynamics of Marine Craft - Maneuvering and Sea keeping, 2004; World Scientific Publishing Co. Pte. Ltd.
4. H.E Saunders; Hydrodynamics in Ship Design, 1957, Vol. I, II, III; the Society of Naval Architects and Marine Engineers.
5. Odd M Faltinsen; Hydrodynamics of High Speed Marine Vehicles; Cambridge University Press.
6. Rawson and Tupper; Basic Ship Theory Vol. II; Butterworth-Heinemann, 2001.
7. Tristan Perez; Ship Motion Control, Course Keeping and Roll Stabilization Using Rudder and Fins, 2005; Springer.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	Introduction to Seakeeping, Wind Generated Waves, Regular Wave Theory.	**3**	**15%**
	Wave Spectrum, Types of Spectra, Ship in Regular Waves.	**3**	
	Equations of Motion, Ship-Wave Encounter, Strip Theory.	**3**	
II	Ship in Seaway and Dynamic Effects, Pitch and Roll in Irregular Waves, RAO.	**3**	**15%**
	Derived Responses: Slamming, Deck Wetness, Relative Motions, Sea-Sickness.	**3**	
	Added Resistance, Powering in Waves, Wave Loads.	**2**	
FIRST INTERNAL EXAM			
III	Introduction to Maneuverability: The Control Loop, Path Keeping, Various Types of Directional Stability.	**3**	**15%**
	Basic Hydrodynamics and Motion Equations of a Maneuvering Body, Control Fixed Stability Indexes.	**3**	
	Turning Trials, Zig Zag Manoeuver, Spiral Manoeuver, Pull Out Manoeuver.	**3**	
IV	Experimental Determination of Hydrodynamic Derivatives (Rotating Arm technique, Planar Motion Mechanism).	**3**	**15%**
	Rudder: Geometry, Hydrodynamics of Flow Around Rudder.	**2**	
	Type of Rudders, Maximum Rudder Deflection Angle and Deflection Rate, Rudder Stock Location.	**3**	
SECOND INTERNAL EXAM			
V	Design Considerations for Sea Keeping: Seakeeping Performance Criteria and Ship Seaway Responses, Factors Affecting Pitching, Heaving and Rolling.	**4**	**20%**
	Ship Motion Control- Control of Roll and Pitch, Active and Passive Stabilizers.	**2**	
	Theoretical Computation of Hydrodynamic Derivatives.	**2**	
	Controllability in the Ship Design Spiral, Effect of Hull Configuration on Controls-Fixed Stability; Effect of Hull Configuration on Nonlinear and Linear Manoeuvers.	**3**	
VI	Seakeeping of High Performance Ships- Catamarans, SWATH, Planning Craft, Hydrofoil Craft, Air Cushion Vehicles, Surface Effect Ships.	**5**	**20%**
	Heel During Turn.	**2**	
	IMO Maneuvering Standards.	**4**	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB302	SHIP DESIGN - I	3-1-0-4	2016

Prerequisite : Nil

Course Objectives:

- To provide an understanding of basic design methodologies and the components of the ship design process.
- To provide knowledge on importance of safety considerations within the ship design process and its impact on operational and economic considerations.

Syllabus:

Introduction to Ship Design, Engineering Economics in Ship Design, Operating Cost, Owner's Requirement; Methods of Ship Design, Design Spiral, Design Categories, Ship Parameters; Estimation of Main Dimensions, Estimation of Lightship Mass ; Design of Hull Form, Lines Plan, Stern and Stem Contours; General Arrangement; Freeboard and Load Line Regulation, Tonnage Measurement.

Expected Outcome:

Upon successful completion of the course, the student will be able to understand and demonstrate knowledge on:

i. Basic tools and methodologies used in the ship design process.
ii. Estimating suitable dimensions for a new ship design, to carry out checks on its capacity, mass balance compliance with statutory regulations, and to assess its economic viability.
iii. Interpretation and application of statutory regulations and classification rules in preparation of General Arrangement drawings.
iv. Statutory and regulatory requirements in ship design.
v. Design process to subdivide and layout a ship ensuring a space balanced ship which meets regulations.

Text Books:

1. D.G.M. Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series 2002.
2. Robert Taggart; Ship Design & Construction; SNAME.

Reference Books:

1. Apostolos Papanikolaou et al; Risk-Based Ship Design - Methods, Tools and Applications; Springer.
2. E.C. Tupper; Introduction to Naval Architecture, Butterworth-Heinemann.
3. Lewis E.U.; Principles of Naval Architecture (2nd Rev.) Vol. III; SNAME
4. MARPOL Consolidated Edition.
5. Martin Stopford; Maritime Economics; Routledge.
6. Rawson and Tupper; Basic Ship Theory Vol I and II; Butterworth-Heinemann.
7. S. C. Misra; Design Principles of Ships and Marine structures, CRC Press, 2016
8. Schneekluth H.; Ship Design for Efficiency and Economy; Butterworths.
9. Thomas Lamb; Ship Design & Construction, SNAME, 2003

Course plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Introduction to Ship Design:** General Aspects of Marine Activities, Transportation of Cargoes, Marine Services & Operations, Marine Industries.	5	15%
	Engineering Economics in Ship Design: Economic Criteria, Initial Cost, Operating Cost, RFR; Owners Requirements.	5	
II	**Methods of Ship Design:** Design Using Basic Type Ships, Design Using Coefficients, Design Using Iteration Methods; Design Spiral; Design Categories - Dead-Weight Carrier, Capacity Carrier, Linear Dimension Ship.	6	15%
	Ship Design Parameters: Displacement, Displacement Coefficient, Displacement Equation, Volume Equation, Solution of the Cubic Equation.	5	
FIRST INTERNAL EXAM			
III	**Ship Main Dimensions:** Length, Breadth, Depth, Draught, Form Coefficients; Shape Of The Hull; Estimation Lightship Mass – Steel Mass, Outfit Mass, Engine Plant Mass; Dead Weight.	6	15%
IV	**Design of Hull Form:** Generation of Lines Plan, Conventional Methods, Distortion of Existing Form, Stem and Stern Contours, Bulbous Bow & Recent Developments.	5	15%
SECOND INTERNAL EXAM			
V	**General Arrangement:** Subdivision of Ship's Hull, Arrangement of Spaces, Arrangement of Tanks, Superstructure and Deckhouses, Arrangement of Engine Plants, Cargo Handling Capacity.	7	20%
	Hold Capacity and Stowage Factor.	5	
VI	**Freeboard and Load Line Regulations:** Stability – Stability Booklet, IMO Regulations, Checks on Stability, Trim.	5	20%
	Tonnage Measurement: Tonnage Measurement of Ships, Suez Canal and Panama Canal Special Tonnage System.	2	
	Influence of Stability, Resistance, Propulsion and Ship Hydrodynamics Factors on Ship Design	5	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB303	STRUCTURAL DESIGN OF SHIPS	2-1-0-3	2016

Prerequisite: Nil

Course Objectives:

- To provide an overview of functional requirement of ship structures and to impart knowledge on various structural components of ships.
- To understand various structural arrangements in a ship.

Syllabus:

Introduction to Ship structures, Structural strength requirement of ships, Framing systems, Structural components **;** Bottom Structure, Machinery Seats, Shell Plating, Bulkheads, Watertight Doors, Tanks, Pillars**;** Decks, Hatches, Superstructure, End Structures; Machinery seat, Midship Section of Various Types of Ships, Structural Design Features of Specialized Vessels.

Expected Outcome:

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

i. Understand the functions and design considerations of various structural components of ships.
ii. Understand the arrangement of bottom structure, shell plating and watertight bulkheads of a ship.
iii. Understand the structural arrangements in fore and aft construction.
iv. Understand the structural design features of specialized vessels.

Text Books:

1. D J Eyres and G J Bruce; Ship Construction, Butterwoth Heinemann, 2012.
2. Robert Taggart(Ed); Ship Design & Construction; The Society of Naval Architects and Marine Engineers, New York, 1980.

Reference Books:

1. D.G.M. Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series 2002,
2. R. N. Newton; Practical Construction of War Ships, Longmans, 1970.
3. Y Bai; Marine Structural Design; 2003, Elsevier,
4. Yasuhisa Okumoto et al; Design of Ship Hull Structures - A Practical Guide for Engineers, Springer

Course Plan

Module	Content	Hours	Sem Exam Marks
I	**Introduction to Ship Structures**- Development of Ship Types- Dry Cargo Ships, Container Ships, Barge-Carrying Ships, Ro-Ro Ships, Bulk Carriers, Car Carriers, Oil Tankers, Passenger Ships, Cargo Handling Equipments.	2	15%
	Shipbuilding Technology- Process of Shipbuilding, Role of Classification Societies.	1	
	Structural Requirements- Longitudinal Strength, Transverse Strength, Local Strength.	1	

	Framing System- Longitudinal Framing, Transverse Framing, Combined Framing.	1	
	Basic Structural Components- Stiffeners, Longitudinals, Frames, Stringers, Brackets.	1	
II	**Bottom Construction**- Functions; Keel- Flat, Duct, Bar. **Single-Bottom Structure**– Components. **Double-Bottom Structure**- Inner Bottom Plating, Floors, Transversely Framed Double Bottom, Longitudinally Framed Double Bottom, Additional Stiffening in the Pounding Region, Testing of Double-Bottom Compartments. **Machinery Seats.** **Shell Plating**- Bottom Shell Plating, Side Shell Plating. **Local Strengthening of Shell Plating**- Additional Stiffening for Panting, Strengthening for Navigation in Ice. **Bilge Keel Structure.**	6	15%
FIRST INTERNAL EXAM			
III	**Bulkheads**- Spacing of Watertight Bulkheads, Construction of Watertight Bulkheads, Testing of Watertight Bulkheads. **Watertight Doors.** **Tanks**- Deep Tanks, Construction of Deep Tanks, Testing of Deep Tanks, Topside Tanks. **Shaft Tunnel**- Construction of the Shaft Tunnel. **Pillars**- Spacing of Hold Pillars, Pillar Construction.	6	15%
IV	**Decks**- Deck plating, Deck Stiffening. **Hatches**- Hatch Coamings, Hatch covers, Bulwarks - Construction of Bulwarks. **Superstructure & Deckhouses**- Forecastle, Bridge Structures, Poop Structure, Superstructures in Passenger Ship, Weathertight Doors.	6	15%
SECOND INTERNAL EXAM			
V	**End Structures** – Introduction. **Fore End Structure**- Stem, Bulbous Bows, Chain Locker, Construction Of Chain Locker, Hawse Pipes, Bow Thruster Units.	4	20%
	Aft End Structure - Stern Construction, Stern Frame; Rudders- Rudder Construction Rudder Pintles, Rudder Stock, Rudder Bearing, Rudder Trunk; Steering Gear; Sterntube, Shaft Bossing And 'A' Brackets.	5	
VI	**Midship Section Of Various Types Of Ships** - General Cargo, Bulk Carrier, RO-RO, Container Ship, Tanker, Container Ship etc. **Structural Design Features of Specialised Vessels** - Submarines, LNG Carrier.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB304	STRENGTH OF SHIPS-II	2-1-0-3	2016

Prerequisite : SB307 Strength of ships - I

Course Objectives:

- To impart knowledge on plated structures used in ship design.
- To provide knowledge on analysis of submarine structure.
- To impart knowledge on torsional behaviour of ship structures.
- To impart knowledge of ultimate strength of ship structures.
- To impart knowledge on vibration analysis and the methods to minimise vibration.

Syllabus:

3D Modelling of Ships Structures and Analysis, Longitudinal Strength Analysis During Launching, Docking, Grounding and Collision, Influence of Super Structure on Longitudinal Strength; Analysis of Submarine Structure; Torsion of Ship's Hull, Ultimate Strength Analysis; Vibration Analysis.

Expected Outcome:

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

i. Understand the principles of 3D modelling of structures used in ship structures.
ii. Understand and demonstrate knowledge in analysis of submarine structures.
iii. Assess ultimate strength of plates, beams and structures.
iv. Characterise the vibrational features of plated structures.

Text Books:

1. Lewis E. U.; Principles of Naval Architecture, SNAME, 1989
2. Owen Hughes; Ship Structural Analysis and Design, SNAME, 2010
3. Tupper E. C.; Introduction to Naval Architecture, Butterworth Heinmann

Reference Books:

1. DGM Watson; Practical Ship Design, Elsevier Ocean Engineering Book Series.
2. Muckle W.; Strength of Ships, Edward Arnold, 1967
3. Y. Bai; Marine Structural Design, 2003, Elsevier.
4. Yasuhisa Okumoto et al; Design of Ship Hull Structures - A Practical Guide for Engineers, Springer.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**3D Modelling of Ship Structures and Analysis**, Small Deflection Analysis of Thin Plates with Transverse Loads and Combined Loads; Large Deflection Analysis; Buckling of Thin Plates; Analysis of Stiffened Plates, Buckling of Stiffened Plates.	8	15%
II	**Longitudinal Strength Analysis:** During Launching, Docking, Grounding and Collision.	6	15%
	Influence of Super Structure on Longitudinal Strength.		
FIRST INTERNAL EXAM			

III	**Analysis of Submarine Structure**- Membrane and Bending Theory; Equations of Cylindrical Shells; Analysis of Stiffened Cylindrical Shells; Analysis of Frames and Bulkheads; Buckling of Unstiffened and Stiffened Cylindrical Shells.	7	15%
IV	**Torsion of Ship's Hull** - Determination of Shear Centre and Shear Flow Calculation of Thin Walled Beams; St. Venant Torsion and Theory of Restrained Torsion; Influence of Deck Transverse and Ship Ends.	7	15%
SECOND INTERNAL EXAM			
V	**Ultimate Strength Analysis**- Application of Plastic Theory to Ship Structures; Basics of Plastic Theory and Definitions; Safety Factors; Damage and Collapse of Ship Structures; Ultimate Strength of Hull Girder; Application of FEM for Ultimate Strength Analysis.	7	20%
VI	**Vibration Analysis**: Introduction to Hull Structure Vibration, Modes of Hull Structure Vibration, Sources of Vibration and Measures for Control of Vibration; Vibration Analysis of Beams, Boundary Conditions in Hull Structure Vibration.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB305	OFFSHORE STRUCTURES	2-1-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce the domain of offshore engineering, its history and significance.
- To introduce the oceanic environment.
- To introduce the loads acting on floating and fixed structures, the methods of calculation of these loads and response of structures.
- To introduce offshore installation methods.

Syllabus:

Historical Development of Offshore Structures-Function, Configuration & Types of Offshore Structures- Novel & Small Field Offshore Structures- Oceanic Environment- Loads on Offshore Structures- Response of Structures- Introduction to fixed offshore platform design- Introduction to floating offshore platform design- Offshore Installation.

Expected Outcome:

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

i. Demonstrate a general awareness of offshore engineering by being familiar with the terms, definitions, types of structures and their application.
ii. Demonstrate a basic understanding of surface gravity waves, wave theories and applicability regime.
iii. Demonstrate a basic understanding of the sea loads (wind, wave & current) acting on offshore structures and their applicability regime.
iv. Demonstrate basic understanding of the offshore design process.
v. Identify and list the function of the different components of conventional offshore structures.
vi. Demonstrate overall awareness of offshore installation methods.

Text Books:

1. Subrata. K. Chakrabarti; Handbook of Offshore Engineering Vol I & II; Elsevier.
2. Angus Mather; Offshore Engineering- An Introduction; Witherby & Co.

Reference Books:

1. D.V Reddy, A. S. J Swamidas; Essentials of Offshore Structures- Framed & Gravity Platforms; CRC Press.
2. Mohammed A El Reedy; Offshore Structures- Design, Construction and Maintenance; Gulf Professional Publishing.
3. S.K Chakrabarti; Hydrodynamics of Offshore Structures; WIT Press.
4. William L. Leffler, Richard Pattarozi, Gordon Sterling; Deepwater Petroleum Exploration & Production – A Non Technical Guide; PennWell Books.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Historical Development of Offshore Structures:** Definition of Offshore structures, Brief Historical Development, Selection of	5	15%

	Deepwater Production Concepts, Offshore Disasters; Deepwater Challenges; Functions of Offshore Structures; Offshore Structure Configurations; Bottom Supported Fixed Structures, Compliant Structures, Floating Structures; Classification Societies & Industry Standards.		
	Novel & Small Field Offshore Structures: Bottom Supported Systems, Neutrally-Buoyant Floating Systems, Positively Buoyant Floating Systems.	3	
II	**Oceanic Environment** (Basic Theory Only)**:** Introduction; Ocean Water Properties-Density, Viscosity, Salinity & Temperature; Wave Theory- Linear, Second Order Stokes, Fifth Order Stokes, Stream Function, Stretching Formulae for Waves at SWL, Applicability of Wave Theories, Wave Group, Series Representation of Long Crested Waves; Wave Breaking; Internal Waves; Sea Spectrum (Definition Only), Directional Spectrum (Definition Only); Sea States; Wave Driven Current-Steady Uniform Current, Steady Shear Current, Combined Current & Waves; Wind & Wind Spectrum, Wind Speed; Offshore Environment by Location.	6	15%
FIRST INTERNAL EXAM			
III	**Loads on Offshore Structures** (Basic Theory Only)**:** Introduction- Dimensionless Parameters; Gravity Loads; Hydrostatic Loads; Resistance Loads; Current Loads- Current Drag & Lift Force, Blockage Factor in Current; Steady & Dynamic Wind Loads on Structures; Wave Loads on Structures- Morison Equation, Forces on Oscillating Structures, Combined Wave and Current Loads, Froude-Krylov Force on Structure, Wave Diffraction Force on Structure, Added Mass and Damping Coefficients; Applicability of Morison Force Vs Diffraction Force; Steady Wave-Drift Force – Steady Drift Potential Force, Viscous Drift Force; Slow Drift Wave Forces; Varying Wind Load; Impulse Loads- Wave Slamming, Wave Breaking, Wave Run-Up.	8	15%
IV	**Response of Structures** (Basic Theory Only): Structure Motion in One Degree; Transient Response of Structures; Forced Linearly Damped System; Non- Linearly Damped Structure Response; Motions of Floating Structure; Interaction of Two Floating Structures; Slowly Varying Response; Simplified Computation of Slow Drift Oscillation; High Frequency Response; Types of Hydrodynamic Damping of Floating Systems; Applicability of Response Formulae.	6	15%
SECOND INTERNAL EXAM			

V	**Introduction to Fixed Offshore Platform Design:** Introduction to field development, Design Spiral and Field Development Timeline, Factors That Drive Concept Selection, Field Development Design Phases; Major Structural Components of a Jacket Platform; Types of Loads on a Fixed Platform; Detailed Structural Design Schedule; Selection of Design Parameters (Basics Only); Selection of Member Sizes; Deck Leg & Deck Structure; Jacket Bracing Configurations.	4	20%
	Introduction to Floating Offshore Platform Design: Types of Floating Platforms- Functions of Floating Platforms, Motions of Floating Platforms, Concept Selection; Design of Floaters- Functional Requirements, Configuration Proportions, Weight Control, Stability, Co-ordinate Systems & Transformations.	2	
VI	**Offshore Installation:** Introduction; Fixed Platform Substructures- Types, Jackets, Compliant Towers, Gravity Base Structures; Floating Structures- Types, Installation of FPSOs, Installation of Semi Submersibles, Installation of TLPs, Spar Installation; Load Out Methods; Transportation- Configuration, Barges & Heavy Lift Ships (introduction only), Sea Fastenings/Tie Downs; Platform Installation Methods- Heavy Lift, Launch, Mating.	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB306	MATERIAL SCIENCE	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

1. To provide fundamentals of material structure and behaviour
2. To understand the causes of metal failure and deformation.
3. To determine properties of materials and develop an awareness to apply this knowledge in material design.

Syllabus:

Crystallography, Crystal Imperfections, Types of bonds, Thermodynamics and Kinetics in materials behavior, Phase transformation and Phase diagram, TTT diagram, Heat Treatment, Mechanical Properties of Materials and Testing, Types of failure, Structural Materials, Materials used in Ships. Classification of Steel in Shipbuilding.

Expected Outcome:

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

i. Improvise a material for a given purpose by taking into considerations its mechanical properties, chemical properties, cost, availability etc.
ii. Classify different kind of materials seen around their life.
iii. Relate performance and behavior of a material under different circumstances with its Crystal structure and type of bonding.
iv. List materials used in shipbuilding and their applications.
v. Classify steels used in shipbuilding.

Text Books:

1. L.W. Van Vlack; Elements of Material Science; Addison, Wesley.
2. V. Raghavan; Material Science and Engineering; Prentice Hall of India.
3. W. D. Callister; Material Science and Engineering; Wiley, 2002.

Reference Books:

1. B.K. Agarwal; Introduction to Engineering Materials; Tata McGraw Hill.
2. D.J Eyres; Ship Construction; Elsevier.
3. Fischer; Materials Science for Engineering Students; Elsevier.
4. G.K.Narula; Material Science; Tata McGraw Hill.
5. John Carlton; Marine Propellers and Propulsion; Elsevier.
6. O.P. Khanna; A Text Book of Material Science & Metallurgy; DhanpatRai & Sons.
7. S.C Misra; Design Principles of Ships and Marine Structures; CRC Press –Taylor & Francis Group.
8. Yasuhisa Okumoto; Design of Ship Hull Structures; Springer.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Crystallography:** Atomic Structure; Crystal Structure- Atomic Packing in Crystal; Miller Indices; Structure of Metal, Alloy, Polymer and	2	15%

	Ceramic.		
	Imperfections in Crystals: Point, Line, Surface and Volume Defects; Types of Bonds, Influence of Bond Type on Engineering properties.	3	
	Diffusion: Mechanism of Diffusion in Crystals, Types of Diffusion, Fick's laws.	2	
II	**Solidification:** Nucleation, Crystallisation - Single Crystal and Poly Crystalline Materials, Polymorphism. Gibbs Phase Rule, Hume-Rothery Rules.	2	15%
	Phase Diagram: Phase Rule, Lever Rule; Methods Used to Determine a Phase Diagram; Isomorphous System; Eutectic; Eutectoid, Peritectic Phase Diagrams.	3	
	Iron- Carbon Equilibrium Diagram.	2	
FIRST INTERNAL EXAMINATION			
III	**Heat Treatment:** Purposes and Types; TTT Diagram; Annealing, Normalising, Quenching, Tempering Process, Austempering, Martempering.	3	15%
	Hardenability of Steels, Jomini Test, Surface Heat treatment; Case Hardening, Carburizing, Cyaniding, Nitriding, Flame Hardening, Induction Hardening; Martensite Formation.	3	
IV	**Deformation of Metals:** Elastic, Anelastic and Viscoelastic Behaviour; Plastic Deformation; Mechanism of Slip & Twinning.	2	15%
	Precipitation hardening, Age Hardening- Recovery and Recrystallisation.	2	
	Mechanical Properties of Metals: Stiffness, Young's modulus, resilience etc.	2	
SECOND INTERNAL EXAMINATION			
V	**Failure of Metals:** Types of Failures- Ductile, Brittle, Fatigue and Creep.	2	20%
	Stress Strain Diagram, Ductile Brittle Transition and Griffith's Theory.	2	
	Fatigue failure, Mechanism of Creep, Creep Curve.	1	
	Testing of Materials: Tensile, Fatigue, Creep & Hardness Tests.	3	
VI	**Ship Structural Materials:** Classification of Steel, Different Types of Steel.	3	20%
	Alteration of Properties of steel by Casting, Working, Joining & Sintering.	2	
	Aluminium & Titanium Alloys used in Shipbuilding- Propeller materials.	2	
	Selection of Materials: Specification; Classification Society Rules, National and International Standards for Different Class of Steels.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB307	STRENGTH OF SHIPS- I	2-1-0-3	2016

Prerequisites : SB201 Mechanics of solids

Course Objectives:

- To impart theoretical knowledge in strength of ship structures.
- To familiarize design and optimization of ship structures.
- To provide practical experience in solving problems in ship structure design.

Syllabus:

Introduction to Strength of Ships, Forces Acting on a Ship, Distortion of Ship Structure, Function of Ship Structure, Design Procedure of Ship Structure, Failure Modes; Loads and Moments Acting on Ship Structures in Still Water, Load, Weight & Buoyancy Curve, SF & BM Curve; Loads in Seaway, Wave Loads, Short Term and Long Term Loads, Slamming, Deck Wetness; Longitudinal Strength, Application of Beam Theory, Section Modulus; Transverse Strength; Analysis of Bulkheads.

Expected Outcome

Upon successful completion of the course, the student will be able to demonstrate basic knowledge and understanding of:

i. Static and dynamic loading on ship hull due to cargo and environment.
ii. Longitudinal and transvers strength considerations in ship structural design.
iii. Application of bending theory in structural design of ships.
iv. Calculation of bending stress and shear stress distribution in a cross section of ship.

Text Books

1. Lewis E. U.; Principles of Naval Architecture, Society of Naval Architectures and Marine Engineers, 1989.
2. Owen Hughes; Ship Structural Design, John Wiley & Sons, 1983.
3. Tupper E. C**.;** Introduction to Naval Architecture, ELSEVIER, 5ed., 2013.

Reference Books:

1. Muckle W.; Strength of Ship's Structures, Edward Arnold,1967.
2. Practical Ship Design; DGM Watson; Elsevier Ocean Engineering Book Series 2002.
3. Y Bai; Marine Structural Design, 2003; Elsevier.
4. Yasuhisa Okumoto et al; Design of Ship Hull Structures - A Practical Guide for Engineers, Springer.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Strength of Ships-** List of Forces Acting on a Ship, Distortion of Ship Structure, Function of Ship Structure, Design Procedure of Ship Structure, Modes of Failure, Idealization of Ship as Hull Girder.	7	15%

II	**Loads and Moments Acting on Ship Structures in Still Water-**Loads, Weight and Weight Distribution, Buoyancy and Buoyancy Distribution; Load Curve, Shear Force Curve, Bending Moment Curve, and Deflection Curve, Effect of Thermal Loads.	**7**	**15%**
FIRST INTERNAL EXAM			
III	**Loads in a Seaway**- Moments Due to Regular Waves and Oblique Waves, Representation of Irregular Seaway, Short Term and Long Term Distribution of Loads, Spectral Approach to Response of Ship Structures, Effect of Slamming and Shipping of Green Seas.	**7**	**15%**
IV	**Longitudinal Strength**- Definition, Application of Beam Theory and Hull-Girder Section Modulus; Calculation of Shear Stress Distribution in Cross Section.	**7**	**15%**
SECOND INTERNAL EXAM			
V	**Transverse Strength**- Definition, Moment Distribution Method and Matrix Method for the Analysis of Transverse Frames.	**7**	**20%**
VI	**Design of Bulkheads**- Design of Transverse Bulkheads, Design of Longitudinal Bulkheads, Design of Corrugated Bulkheads.	**7**	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB308	COMPUTER AIDED DESIGN, DRAFTING & MANUFACTURING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To give an overview of the CAD/CAM process.
- To introduce the fundamental concepts in Numeric Control.
- To introduce CNC part programming.
- To give an overview of Computer Aided Process Planning.
- To give an introduction to Industrial Robotics.

Syllabus:

Evolution of CAD, CAM & CIM- Interactive Computer Graphics -Networking for CAD- Wireframe, Surface & Solid Modelling- Naval Architecture Design Software- Numerical Control- Manual Part Programming- Computer Aided Part Programming- APT Language-Computer Aided Process Planning- Group Technology- Flexible Manufacturing Systems- Basic Components of a Robot- Robot Control- Applications of Robots.

Expected Outcome:

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

i. Demonstrate awareness of major Naval Architecture software packages used in the industry.
ii. Demonstrate basic understanding about the functioning of Numerically Controlled Machine tools.
iii. Prepare simple part programs using both manual as well as computer aided part programming methods.
iv. Demonstrate understanding of computer aided process planning and flexible manufacturing systems.
v. Demonstrate an understanding of basic terminology in robotics.

Text Books:

1. Craig John; Introduction to Robotics- Mechanics and Control; Pearson.
2. Groover M.P, Emory W. Zimmers, Jr; CAD/CAM; Prentice Hall of India.
3. Yoram Koren, Numerical Control of Machine Tools; McGraw Hill.

Reference Books:

1. Mikell P. Groover; Automation, Production Systems & Computer Integrated Manufacturing; Prentice Hall.
2. P. Radhakrishnan, S.Subramanian, V. Raju; CAD/CAM/CIM; New Age International Publishers.
3. P.N.Rao; CAD/CAM Principles and Applications; Tata McGraw Hill.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Computers in Design & Manufacturing:** Evolution of CAD, CAM &	3	15%

	CIM; Traditional Design Vs Computer Aided Design; Workstations; Interactive Computer Graphics; Networking of CAD Systems.		
II	**Computer Aided Design:** Wireframe, Surface & Solid Modelling, Engineering Analysis, Design Review & Evaluation, Automated Drafting, Introduction to Major Naval Architecture Design Software.	3	15%
FIRST INTERNAL EXAM			
III	**Introduction to Numerical Control:** Need, Advantages & Disadvantages; Classification- Point to Point, Straight Cut & Contouring Positioning; Incremental & Absolute Systems; Open Loop & Closed Loop Systems; CNC & DNC.	8	15%
IV	**Part Programming:** Part Programming Fundamentals; Manual Programming-NC Coordinate Systems and axes, Tape Format, Sequence Number, Preparatory Functions, Dimension Words, Speed Word, Feed Word, Tool Word, Miscellaneous Functions, Simple Manual Programming Exercises.	5	15%
	Computer Aided Part Programming: Concept & Need for CAP; CNC Languages; APT Language Structure- Geometry Commands, Motion Commands, Post Processor Commands, Compilation Control Commands, Simple Programming Exercises.	5	
SECOND INTERNAL EXAM			
V	**Computer Aided Process Planning:** Traditional Process Planning Vs CAPP; General Methodology of Group Technology; Variant and Generative Process Planning Methods; Artificial Intelligence in Process Planning; Process Planning Software.	9	20%
	Flexible Manufacturing Systems: Introduction; Types; Concepts; Need & Advantages of FMS; Cellular Manufacturing; JIT and GT Applied to FMS.		
VI	**Introduction to Robotics:** Overview of robotics; Basic Components- End Effectors, Sensors; Control of Actuators in Robotic Mechanisms (basic only); Control of Robo Joint- Stepper Motor, Direct Drive Actuators, Hydraulic & Pneumatic Systems (Basics Only); Robot Applications-Material Transfer, Machine Loading & Unloading, Pre-Cutting Operations, Assembly, Welding & Inspection.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB309	PROGRAMMING & DATA STRUCTURES	2-1-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart the basic concepts of problem solving using a computer.
- To learn about the structure of C programming language.
- To construct and analyze various data structures and abstract data types including lists, stacks, queues, trees and graphs.

Syllabus:

Introduction to computer programming- Algorithms and Flow charts- C Fundamentals- I/O Statements- C program Structure- Decision Making Statements and Branching- Arrays- Functions- Pointers- Structures- Data Structures- Array & Linked List- Stack- Queue- Circular Queue- Priority Queue- Trees- Graphs.

Expected Outcome:

On successful completion of the course, the student shall be able to:

i. Write, compile and debug programs in C language.
ii. Design programs involving decision structures, loops and functions.
iii. Master a variety of Abstract Data Type (ADT) and data structures and their implementations.
iv. Apply and implement algorithm design techniques and data structures to solve problems.
v. Demonstrate an ability to design and implement a computer-based system, process, component or program to meet desired needs.

Text Books:

1. Byron S.Gottfried; Programming with C; Tata McGraw Hill.
2. G.S Baluja; Data Structures Through C; Dhanpat Rai & Co.

Reference Books:

1. E. Balaguruswamy; Programming in C; McGraw Hill.
2. Horowitz, Sahni & Mehta; Fundamentals of Data Structures in C++; Galgottia Publishers.
3. Samanta; Classic Data Structures; PHI.
4. Yashwant Kanetkar; Let us C; BPB.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	Introduction to Computer Programming; Problem Solving Using Algorithms and Flow Charts; Features of a Good Program.	2	15%
	Introduction to C; Variables, Keywords, Constants; Data Types; Declaration of Variables; Operators in C; I/O Statements; Basic Structure of a C Program.	5	
	Decision making Statements; if, switch, Conditional Operators; goto Statements.	4	
II	The Loop Control Structure; while-do, while-for, Nested for loops.	3	15%

	Break and Continue Statement; Arrays- One-dimensional arrays- Declaration and Initialization, Two-dimensional arrays- Declaration and Initialization.	**2**	
	Strings-Declaration and initialization; I/O operations on Strings; Standard Library Functions on Strings.	**2**	
	Functions-Need for Functions, Definition; Function Declaration; Function Call; Category of Function.	**3**	
	Recursion.	**1**	
FIRST INTERNAL EXAM			
III	Pointers-Declaration & Initialization; Accessing a Variable Through Pointers; Pointers & Arrays.	**2**	**15%**
	Structure-Defining a Structure; Declaration and Initialization; Accessing Structure Members; Array of Structures; Comparison of Structures and Arrays.	**3**	
	Pointers and Structures.	**2**	
IV	Introduction to Data Structures; Definition of Data Structures; Need for Data Structures; Data structure Operations.	**1**	**15%**
	Linear Data Structures; Array and Linked List- Definition and Implementation, Comparison between Linked List and Arrays, Types of Linked List.	**3**	
SECOND INTERNAL EXAM			
V	Abstract Data Type; Stack and Queue, Implementation Using Array and Linked List, Application; Circular Queue; Priority Queue.	**4**	**20%**
VI	Non Linear Data Structure; Tree-Definition; Binary Tree-Representation Using Array and Linked List; Traversals.	**3**	**20%**
	Graph-Representations-Traversals-Depth First Search, Breadth First Search.	**2**	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB331	MARINE HYDRODYNAMICS & HYDRAULIC MACHINERY LAB	0-0-3-1	2016

Prerequisite : SB201 & SB205

Course Objectives:

- To provide practical experience on various hydraulic machinery.
- To provide knowledge on carrying out marine hydrodynamics experiment and calculations.

List of Exercises/ Experiments (Minimum 12 are Mandatory)

1. Performance Characteristic Tests on Pelton Wheel (Load test & best speed).
   Equipment: Pelton Wheel Turbine Test Rig.

2. Performance Characteristic Tests on Francis Turbine (Load test & best gate opening).
   Equipment: Francis Turbine Test Rig.

3. Performance Characteristic Tests on Kaplan Turbine (Load test & best gate, vane angle opening).
   Equipment: Kaplan Turbine Test Rig.

4. PerformanceCcharacteristic Tests on Single Stage, Multi Stage Centrifugal Pumps at Constant Speed & at Variable Speed. (Actual & predicted curves).
   Equipment: Centrifugal Pump Test Rig.

5. Performance Characteristic Tests on Self-priming, Jet, Airlift and Deep Well Pumps.
   Equipment: Self Priming Pump Test Rig.

6. Performance Characteristic Tests on Hydraulic Ram.
   Equipment: Hydraulic Ram Test Rig.

7. Performance Characteristic Tests on Reciprocating Pump at Constant Speed.
   Equipment: Reciprocating Pump Test Rig.

8. Performance Characteristic Tests on Gear Pump.
   Equipment: Gear Oil Pump Test Rig.

9. Performance Characteristic Tests on Screw Pump.
   Equipment: Screw Pump Test Rig.

10. Impact of Water jet on Flat Plate.
    Equipment: Impact of Jet on Vane Apparatus.

11. Impact of Water jet on Curved Plate.
    Equipment: Impact of Jet on Vane Apparatus.

12. Prediction of Ship Hull Resistance.
    Equipment: Ship Design Software / test facilities.

13. Prediction of Propeller Performance.
    Equipment: Ship Design Software / test facilities.

14. Prediction of Ship Resistance Using Data Obtained from Model Test.
    Equipment: Ship Design Software / test facilities.

15. Study of Roll Decay Tests and Calculation of Roll Period.
    Equipment: Ship Design Software / test facilities.

16. Prediction of Sea Keeping Characteristics.
    Equipment: Ship Design Software / test facilities.

17. Study on Open Water Tests.
    Equipment: Ship Design Software / test facilities.

18. Study on Manoeuvring Performance of Ships.
    Equipment: Ship Design Software / test facilities.

Note: Only major equipments are indicated

Course Outcome:

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

1. Carry out performance characteristic tests on hydraulic machinery.
2. Analyse the results of experiments and compare with the theoretical knowledge.
3. Understand the hydrodynamic model test set up and equipment.
4. Calculate and analysis the results of various Hydrodynamics experiments

Text Book:

- R. K. Bansal; Fluid Mechanics and Hydraulic Machines; Laxmi Publications.
- Edward V. Lewis; Principles of Naval Architecture Volume II & III.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB332	CAD/CAM LABORATORY	0-0-3-1	2016

Prerequisite : SB308 Computer aided design, drafting and manufacturing

Course Objectives:

1. To impart basic training in the use of a Computer Aided Design and analysis Software
2. To impart basic training in the use of modern manufacturing methods like CNC and/or 3D printer.

List of Exercises/ Experiments (Minimum 12 Mandatory)

1. Study of a Computer Aided Design Software (AutoCAD/ Creo Parametric etc)
2. Study of Interactive Computer Graphics.
3. Exercise problems in 3D modelling of simple objects (minimum 5) to get familiarized with the commands.
4. Assembly of a protected type flange coupling.
5. Assembly of a Knuckle Joint.
6. Assembly of a Plummer Block.
7. Assembly of a Screw Jack.
8. Assembly of a 4-way tool post.
9. Assembly of a Feed Check Valve.
10. Assembly of a RANS Bottom Valve.
11. Assembly of a Lathe Tail Stock.
12. Assembly of Oldham's Coupling.
13. Study of Finite Element Software (ANSYS, NASTRAN etc).
14. Stress/Deflection Analysis of a Simply Supported Beam with Point Loads, Uniformly Distributed Loads and Uniformly Varying Loads.
15. Stress/Deflection Analysis of a Cantilever Beam with Point Loads, Uniformly Distributed Loads and Uniformly Varying Loads.
16. Stress/Deflection Analysis of a vessel subjected to internal Hydrostatic Pressure.
17. Stress/Deflection Analysis of a closed container subjected to External Hydrostatic Pressure.
18. Thermal Analysis of a Plate subjected to Boundary Heating.
19. Study and Demonstration of CNC Machining.
20. Study and Demonstration of 3D Printing.

Equipment:

(a) For items 01 to 12	-	*AutoCAD/Creo Parametric etc.*
(b) For items 13 to 18	-	*ANSYS, NASTRAN etc.*
(c) For item 19	-	*CNC Machine Tool.*
(d) For item 20	-	*3D Printer.*

Course Outcome:

After successful completion of the course, the student will be:

i. Familiar in 3D Modelling with at least one CAD Package.
ii. Familiar with FEA of simple structures/ components.
iii. Familiar with modern manufacturing methods like CNC Machining/ 3D Printing.

Text Book(s):

1. P.I. Varghese; Machine Drawing; V.I.P Publishers.
2. S. Ramamrutham, R. Narayanan; Strength of Materials; Dhanpat Rai Publishing Co.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB361	APPLIED THERMODYNAMICS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart knowledge on the fundamental concepts and laws of thermodynamics.
- To introduce the various thermodynamic processes & cycles.
- To impart knowledge on the properties of pure substances.
- To introduce the principle of operation of steam nozzles, turbines and internal combustion engines.

Syllabus:

Introduction; Fundamentals; Zeroth Law of Thermodynamics; Ideal Gas Equation; First Law of Thermodynamics; Internal Energy; Thermodynamic Processes; Work Done and Heat Added; Second Law of Thermodynamics; Clausius Inequality; Entropy; Availability- Irreversibility; Third Law of Thermodynamics; Gas Power Cycles; Thermal Efficiency; Mean Effective Pressure; Properties of Pure Substances; Liquid Vapour Mixtures; Uses of Steam Table and Mollier Diagram; Steam Nozzles; Steam Turbines; Internal Combustion Engines- Types, Principle of Operation; Knocking; Detonation.

Expected Outcome:

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

i. Demonstrate understanding of the laws governing thermodynamic processes.
ii. Demonstrate understanding of the various types of thermodynamic processes and cycles.
iii. Demonstrate understanding of the concept of entropy and appreciate its significance.
iv. Demonstrate understanding of the concepts of availability and irreversibility.
v. Demonstrate understanding of the various gas power cycles and properties of pure substances.
vi. Demonstrate understanding of the principle and operation of steam nozzles, turbines and internal combustion engines.

Text Books:

1. Holman, J.P.; Thermodynamics; McGraw Hill International Student Edition.
2. P.K. Nag; Engineering Thermodynamics, Tata McGraw Hill.

Data Book (Approved for use in the examination):

1. C.P Kothandaraman; Steam Tables with Mollier Diagram; New Age International Publishers.
2. R. S. Khurmi; Steam Tables with Mollier Diagram; S. Chand Publications.
3. S. Domkundwar; Steam Tables with Mollier Diagram; Dhanpat Rai & Sons.

Reference Books:

1. Mathur and Mehta; Thermodynamics and Heat Power Engineering; Jain Brothers.
2. P.L. Ballaney; Thermal Engineering, Vol.I; Khanna Publishers.
3. Yunus A. Cengal, Michael A. Boles; Thermodynamics - An Engineering Approach (SI Units); McGraw Hill

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Fundamentals & Zeroth Law:** Introduction; Basic Definitions (System, Control Volume, Work, Heat Property, Process etc.); Zeroth law of Thermodynamics; Ideal Gas Equation of State. **First Law:** Closed System Undergoing a Cycle; Closed System Undergoing a Change of State; Internal Energy of a System; Expansion Work; Ideal Gas Processes- Isobaric, Isochoric, Isothermal, Adiabatic and Polytropic; Work Done and Heat Added in Different Process; First Law Applied to One Dimensional Steady Flow Process; Flow Energy, Steady Flow Energy Equation.	**9**	**15%**
II	**Second Law:** Various Statements and their Equivalence; Reversible Process and Reversible Cycles; Carnot Cycle; Corollaries of the Second Law; Thermodynamic Temperature Scales; Clausius Inequality; Concept of Entropy, Calculation of Change in Entropy in Various Thermodynamic Processes – Reversibility and Irreversibility; Available and Unavailable Energy ; Third law of Thermodynamics.	**9**	**15%**
FIRST INTERNAL EXAM			
III	**Gas Power Cycles:** Carnot Cycle, Brayton Cycle, Ericcson Cycle, Sterling Cycle etc.; Air Standard Cycles, Otto Diesel, Dual and Joule Cycle; Evaluation of Thermal Efficiency and Mean Effective Pressure.	**6**	**15%**
IV	**Properties of Pure Substances:** p-V, p-T, T-S Diagram for a Pure Substance, Critical Point and Triple Point, Saturation States; Liquid Vapour Mixtures, Dry, Wet and Superheated Steam; Use of Steam Table and Mollier Diagram; Rankine Cycle for Wet, Dry and Superheated Steam.	**6**	**15%**
SECOND INTERNAL EXAM			
V	**Steam Nozzles:** Mass Flow Rate, Throat Pressure for Maximum Discharge, Throat Area, Effect of Friction, Super Saturated Flow. **Steam Turbines:** Velocity Triangles, Work Done, Governing and their efficiencies.	**6**	**20%**
VI	**Internal Combustion Engines:** Classification of I.C. Engines; Principle of Operation of Spark Ignition and Compression Ignition Engines. Two Stroke and Four Stroke; Stages of Combustion in S.I. and C.I Engines, Knocking and Detonation, Factors Controlling Knock and Detonation, Methods of Preventing Knocking and Detonation.	**6**	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB362	MARITIME LAW	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To impart basic knowledge and understanding on Maritime Law & Maritime contracts
- To impart knowledge on Regulations on Marine Safety & Pollution.

Syllabus:

Introduction to Maritime Law, Bills of Lading Contracts, Hague-Visby Rules, The Hamburg Rules, The Rotterdam Rules, Charter Party Contracts, Hybrid Charter Parties, Marine Insurance Law, Payment and Finance for International Trade, Bills of exchange, Ship Building Contracts, Ship Repair Contracts, Ship Sale & Purchase Contracts, International Maritime Organisation, Four Pillars of Maritime Regulations – MARPOL, SOLAS, STCW, MLC.

Expected Outcome:

Upon successful completion of the course, the student will:

i. Have knowledge on International Maritime Law & various Maritime Contracts.
ii. Understand the Regulations on Marine Safety & Pollution from Ships.
iii. Acquire knowledge on Various Maritime Rules & Regulations.

Text Books:

1. Christopher Hill; Maritime Law; Lloyd's Practical Shipping Guides.
2. Guidance for the Ship Operators on Port State Control; The ILO Maritime Labour Convention, 2006.
3. SOLAS consolidated edition, 2014 by IMO.
4. Yvonne Baatz; Maritime Law.

Reference Books:

1. Capt. M. V.Naik & Capt. C. L.Dubey; Maritime Legislation & Ship Board Management for Deck Officers.
2. IMO STCW Convention and STCW Codes.
3. MARPOL consolidated edition, 2011 by IMO.
4. Thomas J. Schoenbaum; Admiralty and Maritime Law (Hornbook Series Student Edition).

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Maritime Law:** Bills of Lading; Electronic Bills of Lading; Bills of Lading Issued under Charter Parties; The Hague and Hague-Visby Rules; Application of the Hague-Visby Rules; The Hamburg Rules; The Rotterdam Rules.	6	15%
II	**Charter Party Contracts:** Choosing the Type of Charter and Factors to be Considered; Obligations between Owner and Charterer regarding Voyage and Time Charter Parties; Risk and Cost Allocation Between Owner and Charterer; Commercial Control of the Vessel; Exception Clauses / Limitations of Liability / International Conventions; The Problem of Delay Under Time and Voyage Charters; Hybrid Charter Parties.	7	15%

FIRST INTERNAL EXAM			
III	**Marine Insurance Law:** The Nature of the Marine Insurance Contract; Capacity to Contract, Good Faith Duties of the Parties and Insurable Interests; The Marine Insurance Act 1906; Types of Policies and Insured Perils; Coverage for General Average and Salvage; Protection & Indemnity Insurance.	8	15%
IV	**Payment and Finance for International Trade:** Bills of Exchange; Collection Arrangements and the Uniform Rules 1995; Letters of Credit; Counter Trade; Bank Guarantees and Performance Bonds; Other Forms of Mercantile Finance.	6	15%
SECOND INTERNAL EXAM			
V	**Shipbuilding Contract:** Method of Payment; Title and Security; Plans and Specifications; Warranties and Limitation of Liability; Completion Dates, Insurance, Taxes.	3	20%
	Ship Repair Contract: Processes Involved in Ship Repair; Contract and Financing Repairs; Cancellations, Variations, Delays, Warranties; Losses and Damage; Insurance and Regulatory Issues; Protecting Rights; Managing Risk, Liability and Disputes.	4	
VI	**Ship Sale & Purchase Contracts: Introduction to Sale and Purchase, Parties, Roles and Contract Forms; The Ship Broker and Formation of the Contract in Sale and Purchase; The Memorandum of Agreement; Performance Guarantees; Default, Remedies and Arbitration.**	4	20%
	The Four Pillars of Maritime Regulations International Maritime Organisation and its Mandate; Overview of ILO and its Specificities; Origins and Content of the Four Pillars - SOLAS, MARPOL, STCW, MLC.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB363	MARINE POLLUTION, CONTROL AND RECOVERY SYSTEMS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

1. To understand different sources of pollution from ships and floating structures.
2. To provide basic knowledge on Marine Pollution, its impact & control.
3. To familiarise various rules and regulations concerning environmental protection.
4. To know various marine pollution recovery strategies and systems employed.

Syllabus:

Introduction to Marine Pollution, Types & Sources of Pollution; International Conventions and Standards, Prevention of Pollution by Oil, IMO Regulations on Oil Pollution, Prevention of Pollution from Sewage, Garbage and Noxious Liquid Substances in Bulk, Regulations for the Control of Harmful Substances Carried by Sea in Packaged Form, Marine Paints and Pollution, Dismantling of Maritime Structures and Ships, Consequences of Marine Pollution, Legal Issues in Marine Pollution, Introduction to Marine Oil pollution Recovery Systems.

Expected Outcome:

Upon successful completion of the course, the students will be:

i. Familiar with different sources of marine pollution, their impact on the marine environment and methods to control them.
ii. Able to appreciate role of various international and regional rules and regulations for marine environmental protection in design of ships.
iii. Able to apply various strategies and methods for marine pollution recovery to minimise impact of pollution.

Text Books:

1. E. Gold; Handbook of Marine Pollution, Gard, Norway, 1985.
2. R.B. Clark, C. Frid & M. Atttrill; Marine Pollution (4th Edition); Oxford Science Publications, 1997.
3. Richard A Geyer; Marine Environment Pollution, Elsevier.

Reference Books:

1. Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal, 8th October, 2005.
2. Guidelines on the Application of Provisions of the International Convention, MARPOL 73-78; Russian Maritime Register, 2015.
3. Jean Marie Massin; Marine Pollution, Vol. 6; Plenum Press.
4. Obert E.F; Internal Combustion Engines & Air pollution, Hopper & Row Pub., New York.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Introduction:** Definition of Marine Pollution, Types of Marine Pollution, Various Sources of Marine Pollution.	3	15%
	Concerns and Consequences of Marine Pollution, Global Warming, Sea Level Changes, Carbon Emissivity and Green Shipping Biodiversity.	2	
	Marine Pollution in the Coastal Zone.	1	
II	**International Conventions and Standards:** IMO, MARPOL, MEPC, SOLAS, UNCLOS, London Convention.	4	15%
	Documentation and Certificates Onboard Ships and Other Floating Production Systems, HNS (Hazardous and Noxious Substances).	2	
	The International Maritime Dangerous Goods (IMDG) Code.	2	
FIRST INTERNAL EXAM			
III	**Prevention of Air pollution from Ships:** Emissions from Ships Engines, Fuel Oil Quality, IMO Marine Engine Regulations, Requirements for Survey and Issuance of International Air Pollution Prevention Certificate (IAPP).	3	15%
	Ozone Depleting Substances, Volatile Organic Compounds from Cargo Tanks.	2	
	Methods to Reduce Air Pollution from Ships, Emission Control Areas, Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP), Special Areas.	4	
IV	**Prevention of Pollution by Oil:** IMO Regulations on Oil Pollution, Segregated Ballast Tanks, Oily Water Separator, Oil Tanker Safety and Pollution Prevention, Escort Tugs for Tankers.	3	15%
	Prevention of Pollution from Sewage, Garbage and Noxious Liquid Substances in Bulk: Definition of Sewage, Garbage, Ship's Equipment and Systems for the Control of Sewage Discharge, Requirements for Survey and Issuance of International Sewage Pollution Prevention Certificates (ISPP).	2	
	Categories of Noxious Liquid Substances, Discharge Provisions and Standards.	2	
SECOND INTERNAL EXAMINATION			
V	Regulations for the Control of Harmful Substances Carried by Sea in Packaged Form.	2	20%
	Causes of Pollution from Ballast Water, Ballast Water Management (BWM) Convention; Bilge Water /Waste Oil	2	

	Management.		
	Dismantling of Maritime Structures and Ships; Occupational Health and Hazards.	2	
VI	**Marine Paints and Pollution:** VOC Content, Anti Fouling Paints.	1	20%
	Legal Issues in Marine Pollution: Insurance and Compensation.	2	
	Introduction to Marine Oil Pollution Recovery Systems: Types of Recovery Systems, Skimming Systems, Oil Storage System, Treatment of Pollutant After Recovery.	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB364	INTRODUCTION TO SUBSEA PIPELINES	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce the domain of subsea pipelines and risers.
- To familiarize the codes governing the design of subsea pipelines and risers.
- To give an overview of flow assurance with regard to subsea pipelines.
- To give an overview of subsea pipeline installation, inspection and maintenance methods.

Syllabus:

Introduction to Subsea Pipelines- Classification- Pipeline Design Analysis- Design Stages- Mechanical Design of Subsea Pipelines- Design Codes- Flow Assurance- Single Phase and Multiphase Flows- Riser Configurations-Pipeline Installation- Pipeline Inspection, Maintenance & Repair.

Expected Outcome:

Upon successful completion of the course, the students will**:**

i. Be able to demonstrate an understanding of the difference between transport pipelines, flow lines, water injection lines and various types of risers.
ii. Be able to exhibit awareness of the codes and standards used in the subsea pipeline industry and solve simple problems.
iii. Be able to demonstrate basic knowledge of the flow assurance process.
iv. Be able to demonstrate an understanding of the different riser configurations and different types of risers.
v. Be able to explain the different methods of subsea pipe laying operation.
vi. Be able to demonstrate basic understanding of the various inspection, maintenance and repair activities carried out on subsea pipelines.

Text Books:

1. Andrew C. Palmer, Robin A. King; Subsea Pipeline Engineering; PennWell Corp
2. Yong Bai, Qiang Bai; Subsea Pipelines and Risers; Elsevier.

Reference Books:

1. C.P. Sparks; Fundamentals of Marine Riser Mechanics; PennWell Corp.
2. Subrata.K Chakrabarti; Handbook of Offshore Engineering Vol-II; Elsevier.

Course Plan:

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Subsea Pipelines :** Classification – Transport Pipelines, Flow Lines, Water Injection Lines, Risers; Design Stages & Processes; Pipeline Design Analysis- Pipeline Stress Checks, Span Analysis, Onbottom Stability Analysis, Expansion Analysis, Installation Analysis.	4	15%

II	**Design Considerations:** Pipeline Design Codes; Material Grade Selection; Material Grade Optimization; Pressure Containment Design; Longitudinal Load Design; Equivalent Stress Criterion; Hydrostatic Collapse; Buckle Arrestors; Onbottom Stability; Vortex Induced Vibrations.	10	15%
FIRST INTERNAL EXAMINATION			
III	**Flow Assurance:** Introduction; Challenges & Concerns; Typical Flow Assurance Process; Fluid Characterization and Flow Property Assessments; Hydrocarbon Flows- Single phase Flows, Multiphase Flows, Slugging, Pigging.	7	15%
IV	**Risers:** Description of the Riser System; Riser Configurations; Riser System Components; Types- Catenary Risers, Top Tensioned Risers, Steel Catenary Risers for Deepwater, Flexible Risers, Drilling and Workover Risers; Riser Analysis Tools; Codes.	6	15%
SECOND INTERNAL EXAMINATION			
V	**Pipeline Installation:** S Lay; J Lay; Reel Lay; Pipelay Semi Submersibles; Piplelay Ships & Barges; Pipelay Reel Ships; Tow or Pull Vessels; Route Optimization; Pipeline Tie-in; Pipeline Trenching/ Burying; Rock Dumping.	8	20%
VI	**Pipeline Inspection, Maintenance & Repair:** Operating Philosophies; Pipeline Security; Operational Pigging; Pipeline Shut Down; Pipeline Depressurization; Inspection by Intelligent Pigging-Metal Loss Inspection Techniques, Intelligent Pigging for Purposes other than Metal Loss Detection; Pipeline Repair Methods- Conventional Repair Methods, General Maintenance Repair; Deepwater Pipeline Repair.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB365	HYDRAULIC MACHINERY	3-0-0-3	2016

Prerequisite: SB203 Mechanics of fluids

Course Objectives:

- To impart understanding of the basic principles of hydraulic machinery.
- To introduce the different types of hydraulic pumps and turbines, their working, applications and accessories.
- To introduce miscellaneous hydraulic systems commonly used in the industry.

Syllabus:

Dynamic Action of Fluid-Impulse Momentum Equation- Flow of Incompressible Fluid Over Fixed and Moving Vanes- Reaction Principle- Energy Transfer in Rotodynamic Machines- Impulse and Reaction Turbines- Velocity Triangles- Theory of Draft Tubes- Selection of Turbines- Centrifugal Pumps- Operating Characteristics of Centrifugal Pumps- Reciprocating Pumps- Rotary Type Positive Displacement Pumps- Miscellaneous Pumps- Hydraulic Press- Hydraulic Accumulator- Cavitation.

Expected Outcome:

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

1. Demonstrate understanding of the fundamentals behind hydraulic machinery operation.
2. Demonstrate knowledge pertaining to the operation and performance of different types of hydraulic turbines and pumps.
3. Demonstrate general awareness of common hydraulic machinery like presses, lifts, rams, cranes etc.
4. Appreciate the causes & effects of cavitation and the susceptibility of hydraulic systems to this phenomenon.

Text Books:

1. Jagadishlal; Hydraulic Machines; Metropolitan Publishers.
2. Dr. R.K Bansal; Fluid Mechanics & Hydraulic Machines; Laxmi Publications.
3. Lewitt E. H; Hydraulics & Fluid Mechanics; Pitman.

Reference Books:

1. Abdulla Sheriff; Hydraulic Machines; Standard Publishers.
2. Govinda Rao N. S; Fluid Flow Machines; Tata McGraw Hill.
3. John H. Pippinger, Tyler Gregory Hicks; Industrial Hydraulics; Gregg Division McGraw Hill.
4. Modi & Seth; Hydraulic Machines; Laxmi Publications.
5. R.K.Rajput; Hydraulic Machines; S.Chand & Company.
6. Som S. K. and Biswas G.; Introduction to Fluid Mechanics and Fluid Machines; Tata McGraw Hill.
7. Stepanoff John A. J.; Centrifugal and Axial Flow Pumps; Wiley & Sons.
8. Yahya S. M.; Turbines, Fans and Compressors; Tata McGraw Hill.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Dynamic Action of Fluid:** Impulse Momentum Equation, Applications– impact of jet; Flow of an Incompressible Fluid Over Fixed and Moving vanes – Work Done and Efficiency ; Reaction Principle, Propulsion of Ships; Basic Equation of Energy Transfer	7	15%

	in Rotodynamic Machines, Components of Energy Transfer; Classification- Axial Flow, Radial Flow, Impulse and Reaction Machines.		
II	**Hydraulic Turbines:** Classification– Impulse and Reaction Turbines; Euler`s Turbine Equation, Velocity Triangles; Pelton Wheel, Francis Turbine Kaplan Turbine – Construction Features and Performance Characteristics; Theory of Draft Tube; Speed Regulation of Turbines, Run Away Speed; Selection, Type and Speed of Turbines.	6	15%
FIRST INTERNAL EXAM			
III	**Rotodynamic Pumps:** General Classification; Rotodynamic Pumps, Construction Features, Classification Of Impellers, Impeller Shapes, Types of Casings; Working of Centrifugal Pumps, Priming, Euler`s head equation – Velocity Triangles, Losses, Head and Efficiencies; Pump Performance Characteristics- Main Operating Characteristics Curve , Selection of Pumps from Performance Curves – NPSH Required, NPSH Available; Multistage Pumps; Pumps in Parallel & Series Operation; Propeller Pumps.	7	15%
IV	**Positive Displacement Pumps:** Reciprocating Pump; Effect of Vapour Pressure on Lifting of Liquid; Indicator Diagram; Acceleration Head, Effect of Friction; Use of Air Vessels, Work Saved, Slip Efficiency ; Pump Characteristics – Applications.	6	15%
SECOND INTERNAL EXAM			
V	**Other Types of Pumps:** Theory & Application of Self Priming Pump; Jet Pump; Airlift or Compressor Pump; Slurry Pump; Positive Displacement Rotary Pumps- Gear, Screw, Vane Pumps.	8	20%
VI	**Fluid Systems** (Theory Only)**:** Introduction; Hydraulic Press; Hydraulic Accumulator; Hydraulic Intensifier; Hydraulic Ram; Hydraulic Lift; Hydraulic Crane; Hydraulic Coupling; Hydraulic Torque Converter; Air Lift Pump; Gear Wheel Pump.	6	20%
	Cavitation: Precaution and Effects; Hydraulic Machines Subjected to Cavitation.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB366	EXPERIMENTAL TECHNIQUES ON SHIPS & MODELS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce the various experimental tests carried out on ships and models.
- To provide knowledge and fundamentals of ship powering through experimental techniques.
- To introduce Sea keeping and Manoeuvring tests.

Syllabus:

Introduction to Experimental Techniques on Ships and Models, Prediction of Ship Resistance, Open Water Tests, Cavitation, Self Propulsion Experiments, Sea Trials, Seakeeping Experiments, Manoeuvring Experiment, Paint Erosion Tests, Smoke Disposal Tests, Rudder Tests, Tuft Tests.

Expected Outcome:

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

i. Predict resistance of a ship and estimate effective power through model testing in a towing tank.
ii. Determine performance of a ships propeller and resulting hull propeller interaction using model experiments.
iii. Study propeller cavitation and to determine its effects on performance of propeller.
iv. Analyse the results to predict delivered power and propeller revolution rate at a given speed of the ship and determine Wake Fraction, Thrust Deduction Factor, and Relative Rotative Efficiency.
v. To analyse performance of ships by using various Seakeeping tests and other manoeuvring devices.
vi. Understand objectives of various sea trials.

Text Books:

1. E.C.Tupper; Introduction to Naval Architecture, Butterworth-Heinemann, 1996
2. S. C. Misra; Design Principles of Ships and Marine Structures, CRC Press, 2015

Reference Books:

1. DGM Watson; Practical Ship Design; Elsevier Ocean Engineering Book Series.
2. Ship Design & Construction; Volume I and II (2003, 2004), The Society of Naval Architects and Marine Engineers.
3. Tony Molland; The Maritime Engineering Reference Book: A Guide to Ship Design, Construction and Operation; Butterworth-Heinemann.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**Introduction To Experimental Techniques, Prediction of Ship Resistance**, Resistance Tests, Total Resistance, Resistance Curves, Resistance Coefficients, Ship Models, Laws of Comparisons and Similarity, Extension of Model Results to Ships, Towing Tank, Instrumentation and Method of Measurements.	7	15%

II	**Open Water Tests:** Objectives, Facilities, Test Set Up, Principles, Procedure, Analysis and Conclusions.	7	15%
FIRST INTERNAL EXAM			
III	**Cavitation Tests** - Cause of Cavitation, Cavitation Number, Classification of Cavitation, Law of Similarities, Cavitation Tests, Prevention of Cavitation.	7	15%
IV	**Self Propulsion Experiments** - Objectives, Instruments and Equipment, Test Arrangements, Basic Principles, Experiment, Results.	7	15%
SECOND INTERNAL EXAM			
V	**Sea trials, Shop Tests.** Maneuvering Trials, Dock Trials, Speed Trials, Observations, Data Presentation and Uses. **Shallow Water Resistance Tests**.	7	20%
VI	**Wake Measurements, Sea Keeping Tests.**	4	20%
	Paint Erosion Tests, Smoke Disposal Tests, Rudder Tests, Tuft Tests.	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB367	INLAND WATER TRANSPORTATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To study the scope and prospects of inland water transportation in a country's trade.
- To familiarize with design and operation of vessels being used through inland waterways.
- To assess the scope of inland waterways for navigation and transportation in Indian scenario.

Syllabus:

Characteristics of Inland Water Transport, Classification of Inland Waterways, Classification of Inland Vessels, Intermodal Transportation, Rules and Regulations for Design of Inland Vessels, Hull Forms for Inland Vessels, Stability of Inland Vessels, Resistance and Propulsion of Inland Vessels, General Arrangement, Mooring and Anchoring, Structural Design, Materials of Construction, Production Techniques.

Expected Outcome:

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

i. Classify different type of inland vessels including special types and river sea vessels.
ii. Familiar with the basic principles governing design and operation of inland vessels.
iii. Design an inland vessel for the given mission requirements.
iv. Inspect the compliance of a given design with statutory rules by regulatory authorities.

Text Books:

1. Kerala Inland Vessel Rules, 2010; Directorate of Ports, Govt. of Kerala.
2. Recommendations on Harmonized Europe- Wide Technical Requirements for Inland Navigation Vessels, Resolution No. 61, Economic Commission for Europe, Inland Transport Committee, United Nations, 2011.
3. Rules and Regulations for the construction of Inland Waterways ships; IRS, January 1997.

Reference Books:

1. Christa sys, Therry Vanelslander: Future Challenges for Inland Navigation, University press Antwerp.
2. Gregor Tarjan; Catamarans - the complete guide for cruising sailors, McGraw Hill Publications.
3. Inland Vessels Act 1917, Ministry of Law and Justice, Gov. of India.
4. Report of the Working Party on the Standardization of Technical and Safety Requirements of Inland Navigation, Economic Commission for Europe, Inland Transport Committee, United Nations, 2013.
5. Safety Code for Passenger Ships Operating Solely in U.K. Categorised Waters, Merchant Shipping Notice MSN 1823 (M), The Maritime & Coastguard Agency, U.K., 2010.

Course Plan			
Module	**Content**	**Hours**	**Sem. Exam Marks**
I	**Introduction.**		15%
	Inland Waterways and their Peculiarities.	2	
	Characteristics of Inland Water Transport.	2	
	Inland Water Transport in India, Classification of Inland Waterways.	2	
II	**Classification of Inland Vessels.**		15%
	KIV Rules, Special Type Vessels, River-Sea Vessels, Dumb Barges, Flotilla/ Pusher Tugs.	3	
	Intermodal transportation – with Sea, Road and Rail; Low Draught and Low Wash, Self-Propelled Vessels.	3	
FIRST INTERNAL EXAMINATION			
III	**Preliminary Design.**		15%
	Dimensional Restrictions of Waterways, Bridges, Bends, Locks and Gates.	3	
	Design using Empirical Relations – Weight Estimation	3	
IV	**Hull Shapes of Inland Vessels.**		15%
	Chine Hull Forms, Development of Hull Forms, Round Bilge, Multihull, Stability of Inland Vessels, Heel test.	2	
	Resistance and Propulsion of Inland Vessels; Special Features – Tunnels, Shrouded Propeller.	2	
	Shallow Water Effect - Determination of Shallow Water Resistance.	2	
SECOND INTERNAL EXAMINATION			
V	**General Arrangement.**		20%
	Cargo Handling & Equipment on Board Systems – Piping Systems, Fire Fighting Appliances, Life Saving Appliances.	4	
	Super Structure Arrangements, Mooring and Anchoring.	2	
	Rules and Regulations of Inland Vessels – I.V Acts.	3	
VI	**Structural Design.**		20%
	Rules of Construction.	3	
	Materials of Construction, Standards.	3	
	Methods of Construction and Production Technologies.	3	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
SB368	SUBMARINES & SUBMERSIBLES	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To impart knowledge on basic design concepts of submersibles.
- To impart knowledge on stability, hydrodynamics and structural arrangements of submersibles.
- To familiarise the student with basic design considerations and application of AUV & ROV.

Syllabus:

Introduction to Submarines and Submersibles, Submarine Design Management and Methods; Classification of Submarines, Generation of Concept Design, Concept Sizing, The Weight/ Space Relationship, Geometric Form and Arrangements, Submarine Hydrostatics; Powering of Submarines, Dynamics and Control of Submarines; Submarine Structures, Failure Modes, Structural Design Philosophy, Submarine Systems, Autonomous Underwater Vehicles & Remotely Operated Vehicles, Powering and Navigation.

Expected Outcome:

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

i. Classify submarines and their main features.
ii. Understand and demonstrate knowledge on design methods, design phases and generation of technical proposal and concept design.
iii. Understand weight assessment and provide control, meeting technical proposal of submarines.
iv. Demonstrate knowledge on concepts of hydrodynamics of submarines.
v. Understand and demonstrate knowledge on structural design considerations of submarines and various failure modes.
vi. Interpret and apply basic design concepts of AUV & ROV, and demonstrate knowledge on its power source & navigation.

Text Books:

1. Y.N. Kormilitsin, O.A. Khalizev; Theory of Submarine Design, Riviera Maritime Media (August 1, 2001)
2. Drew Nelson; Submarines and Submersibles, Gareth Stevens Publishing (January 1, 2013)
3. Kate Hayden; Submarines and Submersibles, DK Readers, 2016

Reference Books:

1. Roy Burcher, Louis J. Rydill; Concepts in Submarine Design, , Cambridge University Press , 1995
2. Anthony J. Watts; A Source Book of Submarines and Submersibles, Ward Lock, 1976
3. James B. Sweeney; A Pictorial History of Oceanographic Submersibles, Crown Pub, 1970
4. James P. Delgado, Clive Cussler; Silent Killers: Submarines and Underwater Warfare, Osprey Publishing; 2011
5. Harry Bohm and Vickie Jensen; Build Your Own Programmable Lego Submersible: Project: Sea Angel AUV (Autonomous Underwater Vehicle), WESTCOAST WORDS (2002)
6. Lance J. Watkins; Self-Propelled Semi- Submersibles: The Next Great Threat to Regional

Security and Stability, Master's Thesis, Naval Post Graduate school, Monterey, California, 2011
7. Robert F. Burgess; Those Magnificent Men in their Diving Machines, A History of Subs and Submersibles (Illustrated), Spyglass Publications, 2012
8. William A. Nash; Hydrostatically Loaded Structures: The Structural Mechanics, Analysis and Design of Powered Submersibles, Elsevier, 1995
9. E. Eugene Allmendinger; Submersible Vehicle Systems Design, SNAME, 1990.

Course Plan:

Module	Content	Hours	Sem. Exam Marks
I	**Introduction to Submarines and Submersibles:** Definition of Submarines and Submersibles, Features of Submersibles, Operating Environment and Requirements.	3	15%
	Classification of Submarines: Early Submarines, Development of Submarines, Modern Era, Submarine Weapons and Antisubmarine Weapons.	4	
II	**Submarine Design Management and Methods:** Design Phases, Development of Technical Proposal and Submarine Design Specifications, Sequence of Building a Submarine, Costing, Design Influence on Cost and Building.	7	15%
	Design Methods: Convergence Methods, Drawing or Graphic Method, Analytical Method, Computer Application in Submarine Design.		
	Generation of concept design: Concept sizing, Concept sizing with AlP systems, Other sizing's, iterations in design.		
FIRST INTERNAL EXAM			
III	**Weight/ Space Relationship:** Purpose, Significance of Density, Weight Assessment and Control, Space, Margin Policy and Budgeting, Space Margin Policy, Other Size Deciding Factors.	2	15%
	Geometric Form and Arrangements: Introduction, Factors Influencing Form and Arrangement, Factors Governing Diameter of Hull, Internal Arrangements.	2	
	Submarine Hydrostatics: First Principles of Flotation, Submarines on Surface, Arrangements of Main Ballast Tanks, Buoyancy Elements, Weight Elements, Trim and Compensating Tanks, Special Tanks, Stability.	3	
IV	**Powering of Submarines:** Introduction, Powering Requirements	1	15%
	Resistance to motion, Speed-power relationship, Surface resistance	2	
	Propulsion: Design Aspects of Propulsion Plants, Design Aspects of Powering	2	

	Dynamics and Control: Concepts, Equations of Motion of a Submarine, Stability and Control in the Horizontal Plane, Stability and Control in the Vertical Plane, Steering and Depth Control Systems, Contributions of Hull Form and Appendages to Control Dynamics, Emergency Recovery.	3	
SECOND INTERNAL EXAM			
V	**Submarine Structures-** Introduction, Operational Requirements for Depth, Pressure Vessel Shape, Shell-Elastic Deformations, Buckling Deformations; Other Failure Modes.	3	20%
	Internal supporting structure, Pressure hull penetrations, Fabrication considerations, Fatigue, Choice of materials, structural design philosophy.	3	
VI	**Submarine Systems:** Requirements, Hydraulic Systems, High Pressure Air Systems, Water Systems, Systems for Hydrostatic Control, Environmental Control Systems, Provision for Escape, Various Electrical Systems.	3	20%
	Autonomous Underwater Vehicles & Remotely Operated Vehicles: Definition, Difference between AUV & ROV, Types, Basic Design Concepts, Materials Used for Construction, Applications, Communication System, Power Source, Navigational System.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration: 3 hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.